

*A Semimonthly Technical Newspaper*

# **Metallurgical & Chemical Engineering**

New York, June 15, 1917 McGraw-Hill Publishing Co., Inc. Vol. XVI, No. 12 25c a copy

**Uehling**

**CO<sub>2</sub>**

**Recorders**

The present fuel situation makes the need of UEHLING CO<sub>2</sub> Recorders imperative. The first step is to know the combustion efficiency or lack of efficiency of your furnaces by accurately determining the percentage of waste. The next step is to prevent or reduce the wastes. Your engineers and firemen cannot accomplish anything if working in the dark. They must be guided continuously by a knowledge of the waste going on.

UEHLING CO<sub>2</sub> Recorders continuously measure the carbon dioxide in waste gases and give you permanent records which are of invaluable assistance. In addition, auxiliary CO<sub>2</sub> indicators at the boiler front act as guides to your firemen.

We offer our wide experience to assist you in matters of fuel and combustion efficiency. Your inquiry will receive close attention.

**Uehling Instrument Company**  
Combustion Economists  
3028 Empire Building  
New York City

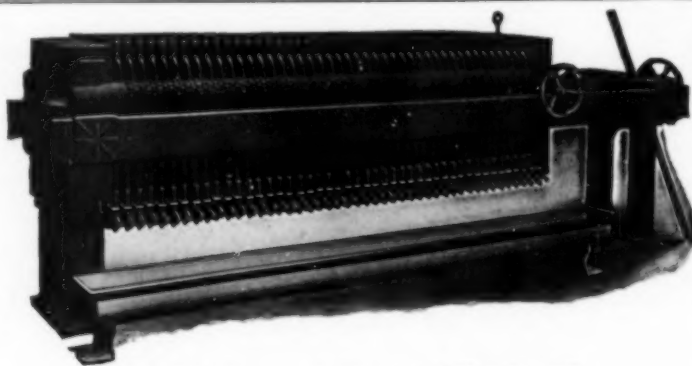
**For Big Production and Low  
Operating Cost**

**SHRIVER  
FILTER PRESSES**

They increase output and effect marked savings in filter cloth replacements and the recovery of values. Little attendance and less wash water adds to their economy.

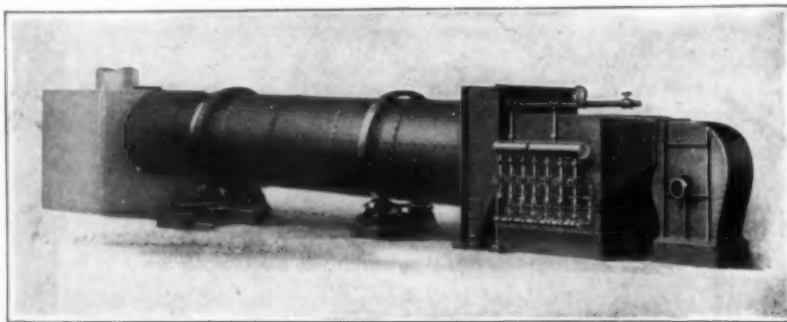
Have wide joint surfaces. Accurate finishing of plates and frames, coupled with an efficient tightening device, prevents leakage.

Presses for all industrial filtration. Small presses for laboratory work.



**T. Shriver & Co.,** 808 Hamilton St.  
Harrison, N. J.

**STEAM HEATED AIR DRYERS**



for Drying Borax, Salts and other Chemicals.

Have equipped largest chemical plants in the world.

Also Direct Heat Dryers for By-Products.

**American Process Co.**

68 William St., New York

**WHEN IN THE MARKET**

**Don't Forget that We Supply  
the Following Metals and Alloys**

Ferro-Titanium, 25% Ti  
Chromium, 98-99% Cr  
Ferro-Chromium, 60% Cr  
Ferro-Vanadium, 40% Va  
Ferro-Molybdenum, 80% Mo  
Cobalt, 97%  
Tungsten, 95%  
Ferro-Tungsten, 70%

Manganese, Pure  
Manganese-Copper, 30/70%  
Manganese-Titanium, 30% Ti  
Manganese-Aluminum, 25% Mn  
Phosphor-Copper, 15% Phos  
Silicon-Copper, 10% Si  
Phosphor-Tin, 5% Phos  
Nickel-Copper, 50/50%

We are also in a position to quote on 50% Electro Furnace Ferro-Silicon manufactured by the Keokuk Electro Metals Company, of Keokuk, Iowa. This plant is now turning out a very high grade alloy, and, being centrally located, offers superior shipping facilities and freight rates. We represent this Company as exclusive selling agents.

Foundries making Brass, Bronze, German Silver, Nickel, Aluminum or composition castings should be sure to investigate our Pure Manganese and Manganese Alloys.

Ask for our pamphlet No. 2041.

**GOLDSCHMIDT THERMIT COMPANY**

THE EQUITABLE BUILDING, 120 BROADWAY, NEW YORK

329-333 Folsom St., San Francisco 7300 So. Chicago Ave., Chicago 103 Richmond St., W., Toronto, Ont.



# Metallurgical and Chemical Engineering

A Consolidation of  
ELECTROCHEMICAL AND METALLURGICAL INDUSTRY and IRON AND STEEL MAGAZINE

Vol. XVI

NEW YORK, JUNE 15, 1917

No. 12

PUBLISHED SEMI-MONTHLY ON THE FIRST AND FIFTEENTH  
OF EACH MONTH BY THE

McGRAW-HILL PUBLISHING COMPANY, INC.

JAMES H. McGRAW, President.

J. H. McGRAW, Jr., Secretary. ARTHUR J. BALDWIN, Treasurer  
239 West 39th St., New York.

TELEPHONE, 4700 BRYANT. CABLE ADDRESS, METCHEM, NEW YORK  
ROCKY MOUNTAIN OFFICE.....401 Boston Bldg., Denver, Col.  
PACIFIC COAST OFFICE.....Rialto Bldg., San Francisco, Cal.  
CHICAGO OFFICE.....Old Colony Building  
CLEVELAND OFFICE.....Leader-News Building  
PHILADELPHIA OFFICE.....Real Estate Trust Building  
LONDON OFFICE.....Hastings House, Norfolk St., Strand

E. F. ROEBER, Ph.D., Editor.  
S. FISCHER, Ph.D., Western Editor.

J. MALCOLM MUIR, Manager.

Yearly subscription price for United States, Mexico and  
United States dependencies, \$3.00; all other countries, \$4.00.  
Single Copy 25 Cents

When change of address is ordered, the NEW and the OLD  
address must be given. Notice must be received at least 10 days  
before the change takes place. No back copies for more than three  
months.

Copyright, 1917, by the McGraw-Hill Publishing Company, Inc.

Entered as Second-Class Matter at the Post Office at New York,  
N. Y., under the Act of Congress, March 3, 1879.

Circulation of this issue 10,000 copies

## Contents for June 15, 1917

### EDITORIAL:

Tendencies in the Zinc Industry.....	673
Impurities in Electrolytic Copper Refining.....	674
Our Economic Future .....	675

### READERS' VIEWS AND COMMENTS:

A Great Library of Applied Science. By Kenneth C. Walker .....	676
Coming Meetings and Events.....	676
Mining Engineers Discuss War Problems.....	676
The Court of Appeals Decision in the Miami Flotation In- fringement Case .....	677
Meeting of New York Section of American Chemical Society..	677
Metallurgists Needed by the Government.....	678
Third National Exposition of Chemical Industries.....	679
Osmotic Pressure. Discussion Before Faraday Society.....	679
Annual Meeting of Iron and Steel Institute in London.....	682
Leads for Electric Furnaces. By Prof. Arvid Lindström.....	683
Impurities in Electrolytic Copper Refining. By Lawrence Addicks .....	687
The Testing of Lubricating Oils. By Hugh K. Moore and G. A. Richter .....	692
Producer Gas and Its Industrial Uses. By F. W. Steere.....	695
Recent Developments in the By-Product Coking Industry of Japan. By T. Kurahashi .....	700
Potash from Cement at the Riverside Portland Cement Co..	701
SYNOPSIS OF RECENT METALLURGICAL AND CHEMICAL LITERA- TURE .....	704
RECENT METALLURGICAL AND CHEMICAL PATENTS.....	706
The Supply of Platinum.....	708
A New Dry Concentrator .....	709
Oxy-Illuminating Gas Lead Burning Apparatus.....	709
A New Hardness Tester.....	710
Cooling Condensing Water in a Dyestuff Plant.....	710
PERSONAL .....	711
BOOK REVIEW .....	711
Current Market Reports—Iron and Steel, Non-Ferrous Metal and Chemical Markets and Chemical Price List.....	711
Industrial—Financial, Construction and Operation and Manu- facturers' Notes .....	715

## Tendencies in the Zinc Industry

Philosophers long ago observed that life is motion and motion life and that consequently things are always in a state of flux. This is analogy built on the laws of physics, which is the science of motion. As analogies go it is a broad, pervasive and accurate analogy. We may then consider that Newton's three laws of motion govern the world of men, women, and things, as well as the world of mass, velocity and acceleration. Of these three laws, the last, that to every action there is an equal and opposite reaction, applies positively to the zinc business at present; and this law finds its counterpart in Emerson's law of compensation.

In what might be termed the metallurgical economics of zinc these two laws, or rather this law in dual form, applies peculiarly, particularly and precisely. It applies peculiarly for the reason that the zinc business is always in a state of kinetic growth and in actual tonnage there has been but one set-back in twenty years. It applies particularly because in the past two and one-half years there has been a period of abnormal growth or a positive action while the reaction is just starting strongly. It applies precisely because both the action and the reaction can be seen by anyone with extreme clearness.

We know that beginning in January, 1915, a period of intense demand raised the price for spelter which continued with a major swing until June of that year and in its minor swing to the middle of 1916, and that for the past twelve months zinc while low compared with the unprecedented maximum is still nearly double the thirty-year average.

During the first two periods the smelter's margin, which is normally only a few dollars per ton of ore, rose to the unheard-of figure of 70. Now this was enormous. New retort plants were built like six-family tenement blocks, against the advice of the conservatives. Straightway, they paid for themselves in two months. Mines, too, shared in the prosperity, for ore rose in price. New mines paid fabulous dividends. Old mines paid even greater. Never was a boom seen in such glory—never was it so plain. It was a fairy-tale; but the statistics proved its reality. For years to come, professors of economics can use it as the typical and classical boom. Price, production, consumption and smelting capacity broke all records.

Now, in this time of inflation, there were sown the seeds of trouble. Chief of these was labor. Whereas the job of condenser cleaner or "connie-boy" paid in 1897 \$1.15 per day, in 1907 \$1.65, in 1917 these young

and unskilled laborers received the aristocratic salary of \$4.15 a day. All other furnace labor requiring more skill and experience has increased and in three years the cost of labor per ton of ore has doubled. Next after labor, fire-clay has become poorer in quality and higher in price. Coal and gas tell the same story. Now while the smelter's costs have increased his margin has decreased. The consequence is that a number of retort plants have shut down, simply because they saw no prospects of making money in the future and left the field to the newer and more efficiently situated plants.

The smelting plants have made efforts to ameliorate their situation by smelting lower-grade ores, in which there was a large margin. This is reflected in the statistics, which show a steady decline in the amounts of spelter made each year per retort. On the other hand, the capacity of the retort has been increased by reason of "heavy charging" and the use of extra men to chisel out the slag formed in the retorts.

During the last two years the recovery of zinc in the reduction process has been abnormally low. Generally it was better business to force the tonnage, waste some zinc, in order to gain spelter. Losses of 25 per cent and even 30 per cent were not uncommon and not unprofitable, when a furnace was being charged with 22,000 lb. or even higher of oxidized ore, as compared with charges of 16,000 lb. in the earlier days. But to-day losses are often what Mr. Ingalls calls little short of a metallurgical crime.

What the future will bring to the zinc business is an uncertain but interesting proposition. A few things are certain. The first of these is that while furnace labor will gain in efficiency, as indeed it is now daily gaining, it will not be materially cheaper than at present. The metallurgical efficiency, or the skill with which the ore is calcined, blended and mixed with coal, will surely be increased. Fire-clay we know will be improved. Devices like equalizing furnaces with machine molding will be installed. There will be consolidations of existing plants with a general staff of consultation and direction, although the tendency in the zinc business is usually along the lines of individualism. Larger retorts, with machine charging and discharging, will be in cases factors making for amelioration.

As zinc is such an essential raw material for war, we can perhaps expect some sort of government control or supervision to stabilize conditions and make for an increased output. The actual competition of the electrolytic zinc plants and the potential competition of other lines of improvement such as the electric furnace must tend in the run of future time to keep the margin of the retort plant small. As most of the mining and smelting companies have made a great deal of money in the past two years, the funds for developmental work are present.

Perhaps the largest field for the retort plant to save lies in the recovery of values in the residues. The field for this is large and sure. With the recovery of

zinc as an oxide, blue-powder or metal, to be sold for commercial purposes, to be used by the electrolytic plant or by the retort plant itself, and with the saving of the values in lead, copper, gold and silver, the economy to the retort plant would be great and appreciatively regarded.

Such an operation would be like the use of the flotation cell in connection with a concentration plant or of the low-pressure turbine in connection with a steam-engine plant.

But we can certainly say that the retort plant is facing the dilemma of increasing costs and decreasing margin. Possibly it is facing a fate similar to that which the steam-engine did twenty years ago. Then the steam-turbine and the gas-engine were coming on the scene. The past decade has told of their success as prime-movers. It is possible that several of the other avenues of zinc-reduction will tell their own story. But just now the retort plant is faced with a hard proposition. And the men making zinc are men and will face in a manly way the action of the great law of compensation. Explicitly, this is that if a man absorbs too much of a colored and flavored solution of ethyl alcohol, the bed will go round at night and in the morning there will be no disputing about the taste of gamboge or sienna in the upper regions of the esophagos. In short, and in physics, to every reaction there is an equal and opposite reaction.

#### Impurities in Electrolytic Copper Refining

Like all articles in Mr. Lawrence Addicks' remarkable serial on electrolytic copper refining, his article published elsewhere in this issue, on the handling of the impurities in copper refineries, is noteworthy and instructive in more than one respect. It states the problem—or problems involved—very clearly, and likewise the change of the problem with the change in smelter practice. It outlines concisely, with equal clarity, the different solutions of the problem worked out in actual practice, whether arsenic or nickel is the controlling impurity. It also brings out clearly the fact that while copper refining is theoretically very simple in its underlying principle, yet in practice, where all the many little details count, it is a very complicated matter; it is a whole art and science in itself, and we are sure that the whole metallurgical profession will feel under obligations to Mr. Addicks for his truly authoritative critical statement of the present status of this important art and science.

The problem of handling the impurities is absolutely fundamental in all wet processes. The process of the operating man is twofold: first, to get the initial starting conditions of operation right; second, to maintain the conditions right during operation. The first is simple, because the choice of the starting conditions is absolutely in the hands of the operator. The second is difficult, because the operating man has no longer the same free choice; he has a given system, and as soon as electrolysis starts things happen in his system

and his system changes from moment to moment, and new things happen, and so on. By the very rationale of the whole process, impurities will go into the electrolyte. Yet to achieve success, these impurities must be controlled. As David H. Browne once said, everything can be done with pure solutions, nothing with foul ones, and eternal vigilance is not only the price of liberty but of the success of electrolytic processes. No wonder here was a serious handicap, and for a time all wet processes were under suspicion. Anton Eilers, with characteristic frankness, once spoke of wet processes as metallurgical Schweinereien, indicating that the fouling of solutions did not fit his æsthetic ideals of a clear-cut metallurgical process. But, after all, the wet process has won out, at least for metal refining. And while leaching processes are a more difficult proposition, we expect to see interest in them revived when once the full possibilities and limitations of flotation are finally established.

### Our Economic Future

Early in January, 1916, Chairman Gary of the United States Steel Corporation issued a statement as to the condition and prospects of the iron and steel industry, saying of industry in general: "There is great expansion at present. I fear there is great inflation." He counseled a "stop, look and listen" policy. Steel prices were then equal to the high prices reached in 1907, the highest since 1902. Now steel prices are \$50 per net ton higher. The next month Sir George Paish, editor of the "Statist," and financial adviser to the British Government, furnished an elaborate article to an American paper in which he made what nearly everyone in the United States considered a very remarkable statement: "The idea that the United States is deriving or can derive any advantage whatever from the war is a complete delusion. All that is happening to the advantage of your country is that it is suffering less than the belligerents as a result of this titanic contest."

Now that we are in the war what would Sir George say? What would Judge Gary say now when steel prices are more than double the prices at the time he counseled caution?

When a country engages in successful war it is the patriotism of those who go to the front that saves it from defeat and the practical patriotism of those who stay at home that saves it from economic ruin. There is an immense economic loss in the time and materials consumed in waging war, so great a loss that it could not be made up except by those at home consuming less and producing more. The people must give up their luxuries and waste less. The women must knit socks instead of playing bridge. The children must play gardening instead of playing something useless. Men must work overtime, and so all along the line.

Undoubtedly we are much less selfish now that we are at war. We may feel entirely unselfish, and yet the advent of war does not destroy the personal viewpoint acquired in years. There has been complaint as to the magnitude of the war taxes Congress has been consid-

ering on the ground that too much taxation would spoil business and then there would be nothing to tax. Silas Wegg wanted Mr. Boffin to pay for the suppression of the will all that its publication would take from him, but Mr. Venus urged that Boffin ought to be left something to make it worth his while, even as much as half, and Congress has taken an even more liberal view than Mr. Venus. It will still be worth while for business to run along.

War taxes, war loans, and everything else connected with the war should be conducted not to preserve business but to preserve industry. In the practical application there is unfortunately a difference. The question works down to the individual. Matters should be so arranged that every individual should produce the maximum of the most useful things, and should consume, or destroy, as little as possible.

Since the war began there have been real profits for many individuals and there has been an apparent profit to the country as a whole through the favorable merchandise trade balance, some five billions or thereabouts. There is doubt whether this is not partly a paper profit, but what is certain is that the material wealth of the country, if it has increased at all, has not increased as rapidly as it does in peace times. There has been some new construction, but it has been largely for the production of war material, of no value when war is over. The five billions or so by which we have improved our financial relations with the rest of the world is something like 2 per cent of the country's material wealth. During nearly three years of war the retardation the war has caused to the increase in our material wealth has been much greater. Economically we are much poorer than if the war had not come.

Physically we have lost very greatly, just as Sir George Paish said. Mentally we have acquired a great deal but what we have acquired will be no gain unless we use it, of no more economic value than an unworked patent. Many bad habits were acquired. Workmen, given wages at undreamed of rates, have become extravagant. Many business men who acquired wealth dreamed of the ease and luxury that would follow their few years of stress. Our own entrance into the war will largely prove an antidote to these infections. Everyone must work harder and we must endeavor to make materially productive the new ideas the war has given us. Our economic position has been impaired, and work, to balance the waste, is the only thing that will restore it. There is no occasion to worry about the situation immediately after the war. Experience shows that what are called "good times" always follow war. After those "good times" there always come "bad times." The lesson men have never learned before is that there really must be something bad about "good times" if they are followed by bad. The goodness is not entirely of the right sort. Too much of the apparent goodness is made by reckless investing or plain reckless spending. Economy and efficiency need to be continued after the war, that the times may be really good and not store up trouble for the later period.



## Readers' Views and Comments

### A Great Library of Applied Science

To the Editor of *Metallurgical & Chemical Engineering*

SIR:—That America has the largest engineering library in the world is excellent. That America should have a large chemical library is manifested in the editorial of your last issue.

It is to be hoped, however, that the ideal of a single large collection of engineering and chemical books should not stop at the gathering together of one single library in one single city. The ideal to strive for upon the completion of a large and, let us say, parent collection, should be for a group of co-ordinated highly technical libraries. By technical libraries I have in mind society, college, public and business house libraries.

Some little time ago, in fact in the *Engineering Record* for March 20, 1915, there appeared an excellent editorial on "The Work of Engineering Libraries." The text of this rather long and to a degree, technical article was summed up in the following: "There are in this country a large group of engineering libraries of great value *collectively*, but not yet suitably *co-ordinated*. Of course the splendid collections of the engineering societies in New York city . . . form a source comparatively accessible to those in the immediate vicinity. In other cities special libraries exist which probably contain unique matter of great value. . . . United effort is just beginning to take effect, and efforts are being made to furnish bibliographical and other information. . . . *The trouble is that these efforts are generally individual and have not been fully correlated.*"

In the above article is to be found a pointer for a great effort to be launched for the establishment of a suitable powerful directing head with well chosen units throughout the United States.

For some time the writer had kept in mind the article just quoted from the *Engineering Record*, and at every opportunity talked with other librarians doing technical work, either in public libraries or industrial houses, as to the possibility of launching a co-ordinating movement. It was hoped that the Special Libraries Association, composed of librarians in public, college and industrial houses, might officially undertake this work. To that end the writer was asked to read a paper on "Co-operation Between Libraries and the Engineering Profession."

After considering the subject and drawing together facts on paper, the writer sent the first draft to several technical librarians for suggestion and approval. I may be pardoned, then, if I quote the part that appealed to these librarians, on the ground that it has some worth to it. These librarians were, by the way, actively engaged in industrial or society library work.

The part which appealed to them was the summary. To quote, "There should be a committee chosen from this association (the Special Libraries Association, which might now be changed to representative technical librarians, owing to lack of funds for the Special Libraries Association to initiate a committee) with a possible advisory or consulting committee of interested engineers; (2) this committee should work on a roster of sponsored libraries and the published official list distributed widely; (4) the publication of an index of at least the important works of each sponsored collection; . . . (6) education of the clientele in the use of the established library service; (7) the consideration of a short course based on a study of the practice fol-

lowed successfully for over two years by Mr. Hendry of the Applied Science Room of the Pratt Institute Free Library, in exchange for the unorganized inefficient instruction now carried on by several of the engineering schools; (9) rounding up of all additional sources of information (other than libraries); (10) well directed publicity."

The greatest strength and usefulness of a "Great Library of Applied Science" lies in a parent library with well chosen units in well distributed localities of the United States.

KENNETH C. WALKER.

Pittsburgh, Pa.

### Coming Meetings and Events

American Institute of Chemical Engineers, semi-annual meeting, Buffalo, June 20-22, 1917.

American Society for Testing Materials, Atlantic City, June 26-30, 1917.

American Chemical Society, Boston, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 24, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

### Mining Engineers Discuss War Problems

#### Meeting of New York Section of A. I. M. E.

The New York Section of the American Institute of Mining Engineers held a meeting at the Machinery Club in the Hudson Terminal Building on Wednesday evening, June 6. The meeting was devoted to patriotic addresses and to the discussion of plans for aiding the Government in the present crisis.

A business meeting was held at 6.15 p. m. preliminary to the regular meeting, at which officers were elected for the coming season as follows: Chairman, J. E. Johnson, Jr.; vice-chairman, Edgar Rickard; secretary, D. M. Liddell; treasurer, C. A. Bohn. Dinner was served at 7 p. m.

The first speaker was Major George H. Putnam, retired, who delivered a fine patriotic address. He was followed by Captain Dulieux, a member of the French purchasing commission stationed in New York and also a member of the Institute. Mr. Drucker, a member of the Mining and Metallurgical Institute of London, followed. The last two talks were in the nature of greetings from the allies.

It was decided to continue the meetings throughout the summer, and to take up subjects of importance in the present crisis. Representatives of the Government will be asked to address the meetings in order that ways and means may be found for co-operation. At least two or three meetings are planned for the summer.

An announcement of special importance was made at the meeting by Bradley Stoughton, secretary of the Institute. He said that the Mechanical, Electrical and Mining Societies had decided to entertain Dr. Guglielmo Marconi at a dinner, the date of which will be announced later.

## The Court of Appeals Decision in the Miami Flotation Infringement Case

In our issue of June 1 we clearly stated the gist of the important decision of the Court of Appeals in Philadelphia, showing that while the majority opinion of the court, written by Judge Wooley, was technically in favor of the plaintiff (the Minerals Separation) it also appeared to be practically a vindication of the Miami present operating practice, since the three elements which the court decreed as infringing the patents in suit are, in fact, not a part of their present operating practice, but were indeed features of the experimental plant in the experimental stage of the process.

The majority opinion of Judge Wooley, as well as the minority opinion of Judge Buffington, also appear very clearly to sustain the defendant's position as to the limiting character of the U. S. Supreme Court decision in construing patent 835,120 in the Hyde case.

Minerals Separation contended that the Supreme Court had no intention of limiting the patent to any especial violence or duration of agitation, but that its decree was based upon the *critical* amount of oil.

The defendant, upon the other hand, argued that the Supreme Court had found that patentability resided in a combination of the three elements, critical amount of oil, violence and duration of agitation greater than previously disclosed, and resulting froth of a peculiarly persistent character, differing in that from any froth disclosed in the prior art.

As to these conflicting contentions, the majority and minority opinions both seem distinctly to sustain the contention of the defendant, the Miami Copper Company.

Judge Wooley, whose opinion is for the plaintiff (Minerals Separation), technically speaking, since he finds infringement of the patents by the defendant is very clear in his statement referred to in our last issue, "If the only agitation to which the pulp was subjected (after such agitation as in the prior art was necessary to mix the oil and ore) was the agitation of the Callow cells, we would not say that that agitation amounted to or was the equivalent of the violent agitation of the patent disclosure, and constituted infringement; but in the process we are considering, and upon which the decree we are reviewing was based, the Callow cells were not the whole process, but were merely the last of four distinct parts of the process, the other three being the process of the patent or its fair equivalent. Having used the process of the patent in the first three steps in developing the potentiality of the critical quantity of oil and air, and bringing the pulp to a point where, if permitted, it would produce the result of the patent, we feel that the defendant cannot escape infringement by taking an additional step, even though that step, if taken alone, voids the patent."

Judge Wooley clearly indicates here that the Callow cell does not infringe. He also previously stated: "It is equally true that in this fourth step, aeration is direct and is not the result of or caused by agitation. On the contrary, agitation results from aeration, and such agitation, though present in some measure, is not even approximately of the violence and duration of the agitation of the patent. The operation in the Callow cell certainly possesses these distinguishing features from operation of the process where aeration is caused by agitation." Judge Wooley asserts—as the quotation shows—that this expression of the facts is true ("equally true"), the other truth referred to being that the foam immediately subsides upon shutting off the air, and does not arise as it did when "agitation" was arrested.

We do not understand Judge Wooley's statement "that before the Callow cell (or Bubbles tank) is called upon to perform its task, the pulp is always pre-agitated and pro-aerated in some fashion and to some extent." He cannot have overlooked the experiments before the Appellate Court, especially the final experiment, in which the pulp, before charging into the Bubbles machine, was very gently rolled in a bottle so as to produce no froth, and that absence of froth was particularly called to the court's attention. He may have excluded this from his consideration, possibly not having noticed its counterpart in the very voluminous record of the court below, upon much the same principle as he excluded what he calls the fourth process, as he describes the present practice at the Miami mill.

Judge Buffington, in his minority opinion, quotes voluminously from the records and testimony of the discoveries of the process as to the violent mechanical agitation being a requisite. Judge Buffington does not find agitation of this violence or duration in either of the three features considered as infringement by Judges Wooley and McPherson. In everything else they appear to agree.

Contrary to the expectations expressed in our last issue, there has not yet been made, as far as we know, any motion for rehearing or appeal, and it has even been thought possible that there is no necessity for such appeal on the part of the defendant.

## Meeting of New York Section of American Chemical Society

The New York Section of the American Chemical Society held its eighth regular meeting of the season in Rumford Hall, Chemists' Club, on Friday evening, June 8. The vice-chairman, Dr. F. J. METZGER, presided in the absence of the chairman, Dr. J. M. MATTHEWS. The meeting and the dinner preceding were very well attended.

### Coloring Glass by Short Wave Lengths of Light

The first paper of the evening was presented by HARRY ROSENTHAL of 52 East Forty-first Street, New York City, on a new process of coloring glass by short wave lengths of light, i.e., rays produced by the ordinary quartz mercury arc, an X-ray tube, the Coolidge X-ray tube and a special X-ray tube for producing negative electrons.

Previous writers have recorded the beautiful tint and colors assumed by some grades of glass when exposed to the sun and weather. Photographers had noticed that a different time of exposure was required in taking pictures under skylights as the skylights became old. Experiments showed that the change in color in the skylight glass absorbed an appreciable amount of the actinic rays.

The author's first experiments were carried out about eight years ago with an ordinary X-ray tube and induction coil. A faint color was noticed in the glass after about two days' time. The special water-cooled, self-rectifying tube developed by Dr. Coolidge of the General Electric Company proved a much better apparatus and definite results were obtained with this machine. Following the use of the Coolidge tube a special X-ray machine was used. This latter apparatus has a vacuum tube about 4 in. in diameter, with an anode of solid tungsten supported on a rod of molybdenum, and a cathode consisting of a tungsten spiral which can be electrically heated. The vacuum of this bulb remains constant, the penetration of the tube being governed by the heat of the cathode spiral. Unless



the filament is heated the tube shows no conduction in either direction, even with voltages up to 100,000. In coloring optical lenses a light color can be obtained in two minutes with 100 milli-amperes and 50 kilovolts. In four minutes a medium color is obtained and in ten minutes a dark color. By controlling the penetration of the rays, by varying the voltage, different degrees of color can be obtained.

The author showed several samples of glass colored by this method, including optical wedges and optical lenses of amethyst, amber, green and yellow tints. Some specimens of Kunzite (a semi-precious stone) were also shown which had been changed to emerald green. He stated that porcelain teeth could be colored by placing a wedge of aluminium on the teeth, and that porcelain ware can be colored with designs by placing stencils on it.

The coloring of the glass is believed by the author to be due to a physical change in the material, since by heating the glass will resume its former color. The coloring of the purple glass is undoubtedly due to manganese, and the other colors are analogously obtained.

In discussing the paper Dr. Chas. Baskerville asked whether glass so colored would be of practical use in glasses for furnace work. Mr. Rosenthal replied that the amber-tinted glass was valuable for this purpose. He also stated that amber-tinted lenses were used by the Government for binoculars for use in foggy weather. It was also asked whether the colloidal theory had been considered in connection with the reason for the coloring—that is, whether colloidal metals which would produce the color were set free by the action of the light. Mr. Huston said the term colloid was like the word catalysis. He said the latter word had been defined by a former classmate of his as a phrase used by chemists to hide their ignorance.

#### Preparation of Pure Molybdenum

The second paper was presented by C. H. HUMPHRIES of the Commercial Research Company, Long Island City, N. Y., on "Molybdenum." His talk was devoted chiefly to the preparation of pure grades of molybdenum.

He reviewed briefly the geology of molybdenum ores and showed samples of molybdenite and wulfenite. Molybdenite,  $\text{MoS}_2$ , is the principal source of metallic molybdenum. It is reduced by carbon in an electric furnace. The ordinary methods, however, produce a metal which contains some carbide, and in order to obtain pure molybdenum the trioxide or ammonium molybdate has generally been used, as the starting point. The molybdate is made from the sulphide and this is reduced in an atmosphere of hydrogen in an electric furnace, producing a crystalline material which passes through several more stages of purification. The process is analogous to the well known General Electric tungsten reduction process.

This crystalline product is placed in a nickel or nickel-plated boat in a gas furnace and heated to 900 to 1000 deg. C. It is then crushed and screened and reduced again for several hours at 1200 deg. C. It is then examined for oxide by inspection. It appears streaky if oxide is present. If a blue tint is observed on shaking in water oxide is present.

It would be desirable to reduce finally near 1400 deg. C., but there is danger of the material becoming contaminated with iron if a nickel-plated iron boat is used. It is desirable to have less than 0.01 per cent of iron if molybdenum wire is to be made.

After the final reduction the metal is powdered, then pressed in a steel mold and heated in an electric furnace for about a half hour at 1200-1300 deg. The

metal sinters and becomes hard, but is not yet suitable for working. It is then placed in a furnace, the air displaced and a current of about 100 amperes is passed through the metal. It shrinks and forms a true molybdenum rod. It is then swaged and made into smaller rods, wire, foil, etc. The swagging is done hot from the electric furnace at about 1400 deg. The metal runs through dies of high speed steel down to 0.001 in. The smallest size for practical purposes is 0.005 to 0.01 in.

If the pure metal is heated to 1200 deg. several times and quenched the surface can be made glass hard.

In discussing the effect of alkalies, the author said that some molybdenite contains calcium and barium, and that these are hard to keep out of the metal. They prevent working of the metal when present even in the hundredths of a per cent.

The author mentioned an interesting possible use of pure molybdenum, i.e., as a substitute for platinum in jewelry. It is just as beautiful and is permanent and can be produced at present for 25 cents per gram. The main drawback is the difficulty of soldering. It can be welded in an atmosphere of hydrogen, but the method is cumbersome. Another possible use is in X-ray targets. The oxide is used with tannic acid in coloring shoes.

In the discussion following the paper Dr. Herty asked whether any jewelry had actually been made from molybdenum. Mr. Humphries said that experiments were in progress, and that he hoped to have definite results to announce before very long. Dr. Baskerville said he had used nichrome wire at the College of the City of New York for the students as a substitute for platinum in making flame tests, and that he was having some molybdenum wire drawn with a thin film of platinum on it for this same purpose. Mr. Humphries said the platinum and molybdenum could be worked very well together.

#### Metallurgists Needed by the Government

The United States Civil Service Commission announces open competitive examinations for metallurgists as follows:

A vacancy in the Springfield Armory, Ordnance Department at Large, Springfield, Mass., at \$3,000 a year, and future vacancies requiring similar qualifications, at the Springfield Armory or elsewhere, will be filled from this examination.

The duties of this position consist in the superintendence of the acceptance tests of steel and oil, and of the heat treatment of dies and tools.

The applicant should have had experience in the chemical analysis and the photomicrographical examination of steel, and in the prescription and supervision of the heat treatment of tools.

A vacancy in the department of ordnance, navy yard, Washington, D. C., at \$2,000 a year, and future vacancies requiring similar qualifications throughout the United States will be filled from this examination.

The duties of this position will be the laboratory control of: The melting operations in the manufacture of open-hearth, converter, and electric steel castings and ingots; nonferrous mixtures; the heat treatment of forging and casting of both alloy and carbon steels; the interpretations of physical and chemical tests and their application to shop operations.

Until further notice and on account of the urgent needs of the service, applications will be received at any time and the papers will be rated immediately upon their receipt, in order that appointments may be made with the least possible delay.



This examination is open to all male citizens of the United States who meet the requirements.

Applicants for these positions will not be assembled for examination but will be rated according to their education and practical experience in the subjects designated.

Applicants should at once apply for form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.; the secretary of the United States Civil Service Board, postoffice, Boston, Mass., Philadelphia, Pa., Atlanta, Ga., Cincinnati, Ohio, Chicago, Ill., St. Paul, Minn., Seattle, Wash., San Francisco, Cal.; customhouse, New York, N. Y., New Orleans, La.; Honolulu, Hawaii; old customhouse, St. Louis, Mo.; Administration Building, Balboa Heights, Canal Zone; or to the chairman of the Porto Rican Civil Service Commission, San Juan, P. R. Applications should be properly executed, excluding the medical and county officer's certificates, and filed with the Civil Service Commission at Washington as soon as possible.

### Third National Exposition of Chemical Industries

The Third National Exposition of Chemical Industries will be held at the Grand Central Palace, New York, during the week of Sept. 24, 1917. Preparations are in active progress, with an advisory committee composed of Chas. H. Herty, chairman; Raymond F. Bacon, L. H. Baekeland, Henry B. Faber, Colin G. Fink, Bernhard C. Hesse, A. D. Little, R. P. Perry, Wm. Cooper Procter, E. F. Roeber, G. W. Thompson, T. B. Wagner, Utley Wedge and M. C. Whitaker. The managers, Charles F. Roth and F. W. Payne, report that the exposition will be larger and more interesting this year than its predecessors. At the close of the past exposition much of the space available on the two floors then used was re-engaged by the exhibitors for this coming exposition. At the present time these floors are completely taken and the greater part of the available space on the third floor has since been engaged.

A large section of exhibits showing the industrial opportunities the South presents in its many raw materials will be known as the "Southern Opportunity Section." A "Paper and Pulp Industry Section" has been provided and many elaborate exhibits are in preparation for the paper men when the Technical Association of Pulp and Paper Industry members visit the exposition again this year.

Other exhibits will be of interest to men from the rubber and textile industries. Many more dyestuffs companies have engaged to exhibit their products than formerly. Many of the chemical and allied industry companies have so expanded their operations in the past year, and their products and interests have become so numerous that they require much additional space to make adequate showings.

The Bureau of Commercial Economics at Washington is this year again preparing many of the motion picture films that will be shown at the exposition, and many exhibitors have now in preparation pictures showing phases in their work in the manufacture of their products. These will be of great interest, inasmuch as many are of processes that have been photographed for the first time, and their first showings will be made at the show.

The program of speakers has not yet been announced, but we are informed that it will be composed of many of the nation's foremost men, and men who have come to the fore in the nation's hour of need.

### Osmotic Pressure

#### Symposium Before Faraday Society

The eighty-third ordinary meeting of the Faraday Society was held on Tuesday, May 1, 1917, in the rooms of The Chemical Society in London. The meeting was devoted to a general discussion on osmotic pressure. Sir Oliver Lodge presided.

Sir Robert Hadfield, president, in opening the proceedings, said he only did so in order to introduce Sir Oliver Lodge into the chair. Speaking as a metallurgist, he hoped that consideration of the subject under discussion would be found to have some bearing on the scientific problems of ferrous-metallurgy, such as the solution of carbon in iron.

Sir Oliver Lodge referred in the first instance to the general importance of the subject in animal and vegetable economy. That was the practical side; but the discussion was to concern itself with the theoretical side. Osmosis depended essentially on molecular discrimination, and this brought it into relation with evaporation and freezing. The subject could be treated either thermodynamically—disregarding what actually goes on—or from the kinetic standpoint, and that was how the authors of the papers would treat it, Dr. Porter applying the gas theory to the dissolved substance, Mr. Bousfield to the solvent, and Dr. Tinker dealing with the matter on a cohesion basis.

Prof. Alfred W. Porter opened the discussion by the presentation of his paper.

The investigations of Perrin and others upon Brownian motion have demonstrated once for all that the molecular translatory agitation in a liquid is precisely that which is given by gas theory. This had long been suspected but never proved. In considering a solute the dynamical effects of this motion must be taken into account; when the solution is dilute it comes out equal to the experimental value of osmotic pressure. Any other theory of osmosis must not only explain it, but at the same time must *explain away* the effects of molecular agitation. Of course, when the processes by which the final equilibrium state is set up, or the properties of the membrane which make it semipermeable, come to be examined, many interesting connections will certainly be found which will make it possible to express osmotic pressure in terms of them; but the *causa causans* of the whole phenomenon is the molecular bombardment of the solute, and a knowledge of this provides us with the *only way* in which the value of the pressure has been calculated from any direct theory of the mechanics of the solution. The properties of the membrane form a subsidiary problem; they have as much to do with osmotics as the properties of a glass vessel have upon the origin of the pressure experienced from water contained in it.

The experimental values of Lord Berkeley and Morse and their co-workers for sugar solutions can be approximately represented by a formula of Hirn's type,  $P(v - b) = RT$ ; but the values of  $b$  are larger than the volume occupied by the sugar itself. The excess can be attributed to water of hydration. The hydration number found in this way from Morse's determinations diminishes with increase in temperature and also with increase in concentration. The extreme values are 53 and about 3. The value 53 occurs only in a very dilute solution, and the corresponding value obtained from Berkeley's experiments is only 14, which seems a more likely number. If the molecules of sugar and water are represented by spheres of volumes equal to their molecular volumes, between 30 and 45 molecules of water would form a single layer on each sugar molecule. It is exceedingly likely *a priori* that the water round a sugar molecule tends to form a condensed layer

on it which will be continually breaking up under the influence of molecular collisions. There is nothing in osmosis to indicate the degree of association of water molecules with each other; mono-, di-, tri-hydrol are indistinguishable.

Doubt is thrown upon the meaning of the symbol  $N$  in Poynting's and Callendar's modifications of Raoult's equation. Their theories require that  $N$  shall be the total number of real molecules of solvent, whereas thermo-dynamical theory and experiment require that it shall be the number reckoned as of the same complexity as in the vapor state.

Osmotic pressures can be obtained indirectly from vapor pressures by an exact relation first given by the opener; this has been done experimentally by Lord Berkeley. They can also be obtained from latent heats of dilution either by an exact formula given by the opener or by a better-known approximate formula—

$$H_i = u T^{\frac{\delta}{\delta-1}} \left( \frac{P}{1} \right).$$

Values of  $H_i$  are being determined by D. O. Wood; some of these are published now for the first time, and Morse's determinations are checked by them. This mode of indirect determination of osmotic data is very exact because  $H$  depends only upon deviations of  $P$  from the perfect gas law, being zero when  $P$  is proportional to  $T$ .

Dr. F. Tinker then presented a paper on "The Colloidal Membrane: Its Properties and Its Function in the Osmotic System."

In this contribution the kinetic side of the subject of osmosis is developed by the aid of data obtained from the experimental study of colloidal membranes. Evidence is brought forward to show that moisture flowing through a semipermeable membrane is absorbed or superficially condensed on to the surfaces of the colloidal particles composing the film for such time as it is in contact with the membrane.

Generally speaking, osmotic flow takes place from a pure solvent to a solution because the pure solvent induces a greater pressure of concentration of moisture inside the membrane than the solution does. The condition for osmotic equilibrium is uniformity of moisture pressure and concentration within the membrane. To establish this uniformity, a hydrostatic pressure has usually to be placed on the solution in order to bring the moisture pressure generated by it inside the membrane up to that generated by the pure solvent. The particular hydrostatic pressure which does this is defined as the osmotic pressure of solution.

The evidence adduced points to the conclusion that osmotic diffusion is a process similar in character to, but not identical with, the process of vapor distillation. The main difference between the two processes is that the moisture within a membrane is in a much more concentrated condition than it is inside the vapor phase proper. But the resemblance is so great that for purposes of argument and mathematical treatment we can replace the actual membrane by a vacuum; at least this is the case when considering quantities, such as the magnitude of the osmotic pressure, whose value is independent of the nature of the membrane. By means of this simple device the process of vapor distillation becomes a particular type of osmotic diffusion, viz. osmotic diffusion across a vacuum. We can consequently arrive at many of the factors governing the magnitude and direction of osmotic flow, and the magnitude of the osmotic pressure, by considering the factors which determine the relative values of the vapor pressures of the pure solvent and solution respectively. This is done in the latter part of the paper.

Mr. W. R. Bousfield then gave his paper entitled

"Osmotic Pressure in Relation to the Constitution of Water and the Hydrates of the Solutes."

This paper deals with the subject of osmotic pressure from the standpoint of the ternary constitution of water, which alone can explain the curious fact that for a very dilute solution of sugar the osmotic pressure at 0 deg. C. is greater than that at 5 deg. The vapor pressure theory is shown to be sufficient to explain all the phenomena without postulating osmotic pressure as an "expansive force." It is shown that the osmotic relationships can be deduced with great accuracy on the simple hypothesis that the steam molecules in water behave as a perfect gas in the interstices of the solution. The conclusion is that it is not the solute but the interstitial vapor of the solvent which behaves as a gas, and that it is not the activity of the solute but that of the solvent vapor which is responsible for the phenomena.

He then proceeded to discuss the views put forward by Professor Porter. A theory which left out of account, comparatively speaking, the activity of the solvent, seemed to him the wrong way of looking at things. Criticizing the contention that the diffusion, say, of sugar introduced into a solution indicates an expansive force, he maintained that osmosis might be equally regarded as due to the water expanding in the opposite direction. If the pressure of sugar arose from its thermal motion, why at the surface was it the vapor of the water which escaped and not the sugar? What really obeyed the gas law in solution was not the solute but the occluded vapor comprised in the solution. Figures calculated from his theory agreed with those observed more closely than those deduced from Professor Porter's theory.

Dr. S. A. Shorter held that the "gas law" of osmotic pressure, though simple from an algebraical point of view, was very complex from the point of view of the kinetic theory, so that the law formed a very unsatisfactory basis for the theory of the ideal dilute solution. The correct basis for the theory was Henry's law, which stated that the partial pressure of the solute was proportional to its concentration, and which was readily established on theoretical grounds—simply following from the obvious consideration that the field of force, in which each solute molecule moved, was not affected by the addition of further solute molecules. The constant of proportionality depended upon the nature of the intermolecular forces, being vastly greater in the case of, say, solutions of benzene in water than in the case of, say, solutions of methyl alcohol in water. From Henry's law we could readily establish Raoult's law and the "gas law" of osmotic pressure, neither of which could be deduced from simple theoretical considerations, and neither of which contained any reference to intermolecular forces. This latter point constituted a grave defect in the ordinary osmotic theory. Since it ignored intermolecular forces in dilute solutions, it led many investigators to ignore them in concentrated solutions, and to adopt the totally unjustifiable procedure of postulating certain ideal properties of a concentrated solution, and then ascribing departures from this ideal to chemical action (dissociation, association, or solvation). Now, it was evident, from a consideration of the theoretical basis of Henry's law, that intermolecular forces must control the mode of variation with concentration of the partial pressure of the solute in a concentrated solution. The same must be true of the partial pressure of the solvent, and of the osmotic pressure, since they were both related thermo-dynamically to the partial pressure of the solute. Theories of the chemical structure of concentrated solutions, based on the concept of the ideal concentrated solution, were fundamentally unsound.



The most necessary step toward a fuller knowledge of the processes operative in solutions was the further development of the kinetic theory of solution. The points to be explained first of all were not the comparatively minute deviations from some imaginary ideal behavior exhibited by certain solutions, but such broad questions as the existence of different types of partial vapor pressure curves, the total or partial miscibility of liquids, the existence of a critical temperature with respect to miscibility, etc.

The Earl of Berkeley, as an illustration of one of the difficulties in the internal vapor pressure theory, referred to the diffusion which would take place if a layer of potassium bichromate were placed at the bottom of a column of concentrated sulphuric acid, the vapor pressure of which was practically nil. He inquired as to the accuracy of the latent-heat method of measuring osmotic pressure.

Prof. J. C. Philip stated difficulties he felt with regard to Dr. Tinker's explanation of the selective action of the membrane. As far as size was concerned, a sugar molecule could pass through the pores of the membrane. If the pores had the power of absorbing water, why should not that water absorbed itself take up the sugar molecules, making the membrane "leak"? Recent experimental work on hydration led to somewhat higher figures for the average number of water molecules associated with sugar in solution than the numbers assumed by Mr. Bousfield, namely, from 11 in dilute down to about 7 in strong solutions. Prof. Porter had obtained similarly higher figures.

Dr. G. Senter, while agreeing largely with Professor Porter's theory, criticized his views on hydration, and in particular the assumption that the uncertainty in the value of  $b$  in Hirn's equation was to be accounted for by hydration.

Mr. W. C. Dampier Whetham thought that the relations between osmotic phenomena and vapor pressure and freezing-point which Mr. Bousfield had deduced amounted in effect merely to a confirmation of thermodynamic relations. To get a satisfactory theory of the mechanism of osmotic pressure it was necessary to begin with first principles, and he thought the gas theory the only one which enabled this to be done.

Prof. A. Findlay, in a written communication, emphasized the importance of distinguishing between the equilibrium pressure and the process by which this was produced. The process of osmosis and the rôle of the membrane had little reference to the main problem of the value of the equilibrium pressure and its relation to the constitution of the solution. He combated the view that osmotic pressure (a term he thought misleading) was to be identified with the expansive force that brought about diffusion, and he could not accept Professor Porter's kinetic treatment of the problem. The weakness in this arose from the use of the equation  $P(v-b) = RT$  in attributing deviations from it to hydration. The connection between heat of dilution and osmotic pressure seemed a fruitful direction for investigation. He favored the view, mooted by Tammann, that osmotic pressure was caused by the inner compression of the solvent in solution. Some recent calculations by Horiba lent support to this theory.

Mr. J. R. Partington, in a written communication, showed how it followed from molecular theory that although the physical state of the dissolved molecules might not be comparable with that of the gaseous molecules, yet they could behave with respect to bombardment as if they were in the state of a gas. The question as to whether the osmotic pressure was "caused" by solute or solvent appeared to him to be largely meaningless.

Mr. F. S. Spiers (communicated) considered that a satisfactory conception of osmotic pressure was arrived at if one regarded it as the *diminution* in the kinetic molecular energy of the solvent due to association with the solute. This view not only took account of both solvent and solute, but it also gave a simple picture of the process of osmosis, and suggested at once the connection between osmotic pressure and vapor pressure.

Prof. Alfred W. Porter replied at this stage to some of the criticisms that had been made. The solute molecules contribute nothing to vapor pressure, simply because when they get near the surface they are drawn downward by the solvent and never succeed in escaping. The answer to Dr. Philip was, he thought, that the canals in the membrane must be narrow compared with the range of molecular action, although not necessarily compared with molecular dimensions. In answer to Lord Berkeley, the method of using latent heat of dilution to determine osmotic pressures gave very considerable accuracy.

Prof. T. S. Moore considered that the modification of the gas theory required to explain the action of a solute in solution was so fundamental that it ceased to be a gas theory. The internal pressure of a solution being exceedingly high, it was impossible to suppose that the pressure exercised by the solute molecules could be independent of the solvent molecules and of the forces exerted by the solute on the solvent, which were the assumptions made by Professor Porter. A molecular theory of osmotic pressure must form part of a general molecular theory of solution.

Sir Oliver Lodge, in bringing the discussion to a close, pointed out that in a liquid they had to deal with an internal pressure, due to the mutual attraction of the molecules, of great magnitude. The source of osmotic pressure was probably to be looked for in this internal pressure.

#### Norwegian Company to Manufacture Peat Fuel.—

A company is in process of formation in Norway for making fuel from peat by the Rosendahl method. The capital of the company is to be between 600,000 and 1,000,000 crowns (between \$160,800 and \$268,000). The raw material for the new industry will be chiefly peat from the extensive Norwegian moors, but any organic material may be used which is sufficiently abundant in the neighborhood of the factory, *e. g.*, wood waste. The product is said greatly to resemble English coal. Preliminary experiments have been conducted not only in the laboratory but also under factory conditions on a small scale, and the product is stated to have been satisfactorily tested in Christiania households.

**University of Wisconsin Summer Session.**—The nineteenth annual summer session of the College of Engineering of the University of Wisconsin will be held at Madison during the six weeks period beginning June 25, 1917. Special courses will be given in Chemistry, electrical, steam and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shop work, and surveying. All courses given in the University summer session are open to engineering students. Special courses have been arranged for engineering, manual arts, and vocational teachers. For information, address F. E. Turneure, Dean, Madison, Wis.

**Fellowship in Refractories.**—The Refractories Manufacturers' Association, whose headquarters are at 220 South Michigan Avenue, Chicago, Ill., has endowed an industrial fellowship at the Mellon Institute in Pittsburgh.



## Annual Meeting of Iron and Steel Institute in London

The annual meeting of the British Iron and Steel Institute was held in London, May 3 and May 4, 1917. An attractive program of technical papers was presented and several interesting announcements were made.

The new president of the Institute is SIR WILLIAM BEARDMORE. Professor HENRY M. HOWE (U. S. A.) was elected an honorary vice-president.

The Bessemer Medal for 1917 was presented to Mr. Andrew Lamberton, in recognition of his work in mechanical engineering appliances in the iron and steel industry.

Following is a list of the papers read at the meeting:

Properties of the Refractory Materials Used in the Iron and Steel Industry. By Cosmo Johns (Sheffield).

The Determination of the Line *SE* in the Iron-Carbon Diagram by Etching Sections at High Temperature *in Vacuo*. By Professor Tschischewsky and N. Schulgin (Tomsk, Russia).

The Influence of Surface Tension Upon the Properties of Metals, Especially of Iron and Steel. By F. C. Thompson (Sheffield).

Cementation by Gas Under Pressure. By F. C. Langenberg (Cambridge, Mass.).

The Penetration of the Hardening Effect in Chromium and Copper Steels. By L. Grenet (Firminy).

The Case-Hardening of Iron by Boron. By Professor Tschischewsky.

Steel Ingot Defects. By J. N. Kilby (Sheffield).

Notes on Some Quenching Experiments. By L. H. Fry (Burnham, Pa.).

Origin and Development of the Railway Rail in England and America. By G. P. Raidabough (Sparrow's Point, Md.).

### REFRACTORY MATERIALS USED IN THE IRON AND STEEL INDUSTRY

The author of this paper, COSMO JOHNS, took up a discussion of the sources and properties of the various refractory materials used by the iron and steel industry in England. He said that the art has been so long in front of the science of the refractory industry, that the most urgent need at present is for an expression, in terms of scientific precision, of the most successful practice in manufacturing the refractory product and of the physico-chemical changes which take place when they are used.

"Tenacity and compressive strength at ordinary temperatures are valuable only in so far as they permit the refractory products to be transported and enable them to withstand the structural stresses to which they are exposed when used. This is not difficult to attain. It is when the material is exposed to high temperatures that the value of these properties becomes most important. The abrasion caused by the movement of solid substances while in contact with their heated surfaces is important, while the erosion caused by the passage of dust-laden gases at high velocities become serious in time. Little or nothing is known of the conditions that favor or retard abrasion and erosion. High tenacity, which in most cases would mean that of the bonding or of the most fusible constituents, is most probably the desired property. It is the surface exposed to the highest temperature which suffers, for it is the one that is in contact with the moving solids, liquids, or gases. Compressive strength is rarely a cause of failure, for the bulk of the refractory material is at a lower temperature than the face and therefore less affected. There is, however, urgent need for accurate determination of the two properties under discussion at wide ranges of temperature for the more important materials under both oxidizing and reducing conditions.

"Not less important than resistance to high temperature with concurrent abrasion and erosion is resistance to the

corrosion caused by slags gases. The effect of acid slags on basic refractories and of basic slags on acid refractories are familiar, while a most striking example might be indicated on the marked corrosion of the silica bricks in the gas ports and uptakes in open-hearth furnaces, due to the alternating passage of oxidizing and reducing gases with the resulting formation of fusible silicates. A factor conducive to rapid corrosion in the last case is the absence of large particles of silica in the bricks employed and the presence of excessive pore spaces. Here again little has been published and few observations recorded. The effect of the alkalies found in certain coals on the refractories used in coke-oven construction is serious, and here too little is known as to the real nature of the destructive influences at work.

"In the case of coke ovens the retention of gas-tight partitions is absolutely necessary, and this involves the use of a refractory material which does not undergo appreciable volume changes. This means that a mixture of substances with volume changes of opposite sign are employed, viz., clay and silica. But while the contraction of the burnt clay is fairly regular with increased temperatures, quartz, which is the form of silica found associated with it in nature, has an inversion point at which it becomes trypidite. In the presence of certain compounds this inversion takes place at a temperature lower than that at which coking is carried on. In their absence the inversion is retarded and does not take place until a temperature higher than that usual in coking practice is attained.

"Owing to the complex nature of most of the materials used in practice, their properties are not those of the simple minerals of which they are composed, but the resultant of variations which are sometimes of opposite sign and are always varying at different rates. The relative size of the grains employed, the extent of the surface exposed by the more resistant constituents to the others used as bond or matrix, are most important factors in contributing to the ability of the material to perform useful service. Another point of some importance is the influence of mass in promoting or retarding inversions. Some of these inversions take place almost instantly once the critical temperature has been reached, but with others marked hysteresis occurs. Porosity must always occur when the refractory material is composed of more than one constituent, and where their chief volume changes are dissimilar or occur at different temperatures. Little is known of the effect of porosity on the properties of refractory materials. That the pores encourage the deposition of extraneous substances in the interior of the bricks, and that they render the structure permeable to gases, is of course obvious.

"The stresses caused by temperature changes are due to the volume changes which take place during heating. If the refractory material happens to be a good conductor of heat these are not serious, unless one face is rapidly heated and the distortion produced exceeds the tenacity of the material. The remedy available is to avoid rapid temperature changes, and whenever possible to raise the temperature of the material during the burning stage of manufacture well above that at which the inversion to the principal volume change should take place, and to hold it at that temperature long enough for the inversion to be completed. The 'spalling' of magnesite bricks which sometimes occurs has been thus explained, and, it is certain that the excessive expansion of silica bricks would be avoided if the manufacturer could ensure the completion of the quartz-trypidite inversion during burning. Despite the considerable advances in our knowledge of the inversion of silica made recently, their bearing on the problems that face the manufacturer are not yet sufficiently clear.

"The first step—and in all probability the one easiest to take—would be to prepare specifications for the most important refractory products expressed in terms capable of precise measurement or description, basing the specification on the best current practice. This would only be following the excellent example of the gas industry. But specifications at their best only serve to stereotype the best current practice of their day. These specifications should be the starting point of systematic research which should cover, not only the problems that occur during manufacture, but the occurrence in nature and characteristics of the raw materials. Their concentration and purification, proximate and ultimate analysis, mineralogical description and thermal analysis are all points on which additions to our present knowledge would be of great value. But the refractory materials are so complex, and the problems involved are so difficult of direct attack, that any contributions to our knowledge of the properties of the pure minerals, or of the impure aggregates which are used in practice, would be welcomed, even if their immediate application did not happen to be possible."

## Leads for Electric Furnaces

By Prof. Arvid Lindström

(Translated from Teknisk Tidskrift, March 7, 1917)

With the increasing size of arc or resistance furnaces the difficulties of conveying the current from the transformer to the furnace have become more pronounced. With electrode potentials of as low as 50 and 100 volts, the current necessarily will be very high, requiring in turn conductors of a large cross-section and under such conditions two difficulties are met with.

One is due to the "skin effect" or the tendency of the alternating current to concentrate in the portion of the conductor nearest the surface; this obviously results in a greater energy loss than would be desirable with a given weight of copper, or a greater weight of copper would be required than would be justified for a certain loss.

The other difficulty is due to the self-inductance of the conductor loop which connects the transformer with the furnace, resulting in a low power factor of this loop, and consequently of the entire installation, with its accompanying disadvantages and additional expenses of different kinds. There are, of course, several types of furnaces (nitrogen furnaces) where a large self-inductance is desired for stabilizing purposes, especially during the starting period, but not even with these does it seem that an inductance inherent and inseparable from the system is desirable.

It is from the above two points of view that the problem of furnace conductors will be dealt with in the following article, and an endeavor will be made to show how the best results may be accomplished when designing the leads, and also how the results may be investigated by tests. As an illustration a known furnace installation will be taken for an example.

### I—The Effective Resistance of Large Conductors and Their Proper Arrangement

It has been known for many years that, especially with round conductors, the resistance with alternating current is greater than with direct current, due to the phenomenon known as "skin effect." For round conductors Hospitalier has calculated a table for the ratio  $\frac{R_e}{R_o} = X = \frac{\text{effective resistance with alternating current}}{\text{resistance with direct current}}$  as function of  $f$  and  $d$ , where  $f$  is the frequency,  $d$  is the diameter of the conductor in cm. (1 centimeter = 0.3937 inch).

From this table the following values only will be given:

$fd^2$	$X$
720	1.32
1280	1.68
2000	2.04
2880	2.39
5120	3.10
8000	3.79

The furnace chosen for the example has a capacity of 900 kilovolt-amperes at the lowest potential of 50 volts, so that the highest current is consequently 18,000 amperes. The frequency is 50. The conductors consist partly of four bars 200 x 15 mm., spaced comparatively close and connected in parallel. This corresponds to a cross-section of 120 sq. cm., or a round solid conductor with

$$\text{Diameter } d = 12.4 \text{ cm.}$$

$$d^2 = 154$$

$$fd^2 = 7700$$

$$\text{and therefore } X = 3.7.$$

With less than one-third of the utilized copper weight it would have been possible to maintain the same resistance and loss if the above skin effect could be avoided. (It may be noted that for 25 cycles  $X$  would have been  $\sqrt{2}$  times less, thus  $X = 2.6$ .) It may now be objected that the conductor did not consist of one single solid round conductor. This is true, but it must



FIGS. 1 TO 3—CONDUCTOR ARRANGEMENT

be remembered that if the conductor is split as, for example, in Figs. 1 and 2, no gain is obtained in this respect if the spaces between the laminations do not take away any appreciable part of the section, and evidently also under the consideration that the laminations are parallel connected at the ends and not transposed along their length. With the exception of at the ends, the current travels nowhere in any other direction than that of the conductor, or, in other words, the current has no component in any other direction, and the current distribution is therefore not at all affected by the splitting up of the conductor.

If instead of being round the conductor had a rectangular or nearly square cross-section, as in Figs. 3 and 4, but of the same area, the conditions would nevertheless not have been much improved. This is readily conceived by comparing the contours of the square and the corresponding circle. The current distribution in the cross-section is a matter which principally depends on the distance of the different current elements from the center.

In our case the four bars are arranged about as shown in Fig. 5. The bars are spaced wider apart and



FIGS. 4 TO 6—CONDUCTOR ARRANGEMENT

the average specific conductivity is consequently less, but not to such an extent that any appreciable decrease of  $X$  is obtained. At the same time as this specific conductivity has decreased, the linear dimensions of the cross-section have increased, and without introducing a too great error it may be assumed that the resistance in this case is approximately three times as great for the 50-cycle alternating current as for direct current, or

$$X = 3.$$

Now the question arises: How shall the conductors be arranged in order that a considerably better result may be obtained? The first thing which suggests itself is the use of only one bar, not too thick but much wider, for example 800 x 15 mm., 600 x 200 mm., or 480 x 25 mm.—in any case a bar whose width is 20 to 50 times its thickness, and we will in the following see what value  $X$  will get in such a case.

Steinmetz has calculated the current distribution in flat conductors in air. Starting out from the same assumptions, the writer has also calculated the effective resistance of similar conductors. The calculations are not given here, but it may be stated that the results are fully analogous to those obtained for conductors in armature slots.

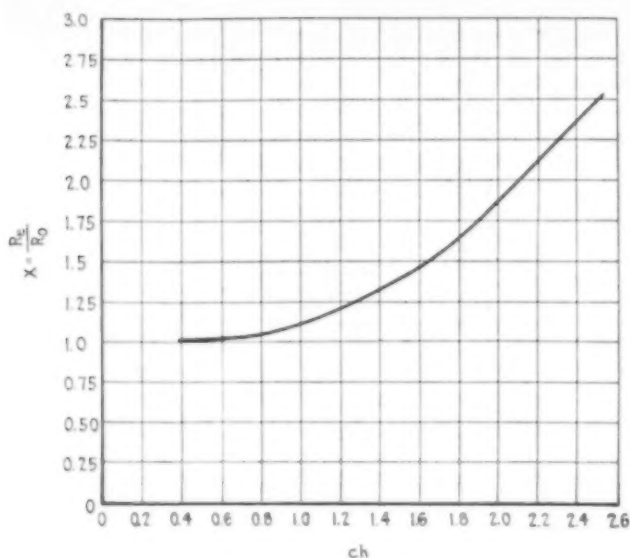


FIG. 6A—DIAGRAM FOR FINDING X

If  $h$  = half the thickness of the conductor in cm.,

$$c = 2\pi\sqrt{\mu\lambda f}$$

where

$\mu$  = permeability of the material,

$\lambda$  = specific conductivity,

$f$  = frequency,

then  $X$  may be obtained directly from the curve in Fig. 6a. This is on the assumption that the width of the conductor is infinite in comparison to the thickness, an assumption which, while not of course strictly true, may be considered to approximately apply to our case. When

$$\lambda = \frac{1}{2000} \text{ for copper } (c = 0.02)$$

$$\mu = 1 \text{ for copper}$$

$$f = 50$$

$$c = 1$$

Then

is now the thickness =  $2h = 1.5, 2.0, 2.5$  cm.

then  $ch = 0.75, 1.0, 1.25$

and according to Fig. 6a  $X = 1.03, 1.09, 1.21$ .

In all three cases, but especially in the first and second, a considerable reduction in the loss (about one-third has been accomplished with the same weight of copper. For example, we could use a conductor  $500 \times 8$  mm., or only one-third of the originally assumed weight, and obtain then

$$X = 1$$

that is, the same loss as that now prevailing. Two-

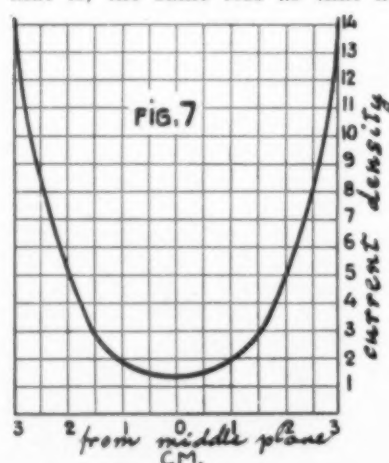


FIG. 7—RESULTS FOR CONDUCTOR OF 60-MM. THICKNESS

thirds of the installed copper could therefore be saved, and the temperature would certainly not be materially higher for this conductor than that of the four bars installed.

If, now, these four bars, Fig. 5, are moved together as shown in Fig. 6, and we treat the  $200 \times 60$ -mm. conductor thus obtained as one of considerable width as compared to its

thickness, we get  $X = 3$ . This result may not be considered as exactly correct, but it points in the right direction and checks with that previously obtained.

The effective value of the current density at the distance  $X$  from the middle plane of the bar may be calculated from the following equation:

$$i = A\sqrt{2}\sqrt{\cos k2cX + \cos 2cX}$$

where  $A$  is a constant and  $c$  has the previous meaning. The result for the conductor with the 60-mm. thickness is given in Fig. 7. The current density nearest the surface is not less than ten times as great as in the center. It is evident that the density varies in the other direction also, so that a concentration will take place both near the upper and lower edges, a condition which is caused by the fact that the width of the conductor is not infinite. In Fig. 5, where an approximate relative view of the cross-section of the actual conductors is given, an attempt has been made to indicate the density in the different parts of the section by shading.

A measurement of the temperature of the bars showed a rise of 32 deg. C. for the two middle bars and 51 deg. C. for the two outside ones, with a current of approximately 14,000 amperes. Considering the poorer radiation of the two former, it is evident that the current in the latter was considerably greater.

Even with the above suggested arrangement with one single bar  $500 \times 8$  mm., a concentration of the current towards the edges must take place, so that even in this case a somewhat increased resistance will result. To avoid this, the conductor may be shaped as a pipe or tube, and if its diameter is fairly large as compared to the thickness of the walls, the calculation used for a bar of infinite width may be applied without appreciable error. With a thickness of 8 mm. the outside diameter

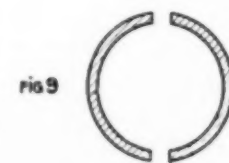
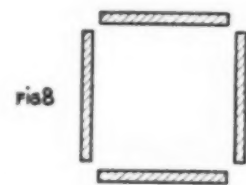
of the tube would therefore be  $\frac{500}{\pi} + 8 = 168$  mm.,

this being based on the assumed area of 4000 sq. mm., which is one-third of that installed (12,000 sq. mm.). With this area, on the other hand, the tube could be built with a thickness of 15 mm. and an outside diameter of  $\frac{800}{\pi} + 15 = 270$  mm. In that case

$$X = 1.03$$

and consequently the resistance approximately one-third of the present.

Another method would be to arrange the four  $200 \times 15$ -mm. bars as shown in Fig. 8, an arrangement which, however, from a practical point of view, appears to be less advisable.



FIGS. 8 AND 9—OTHER ARRANGEMENTS

Instead of an entirely closed tube, it can be separated into two halves as in Fig. 9, but in the former case it is possible to provide for a very effective cooling inside the pipe.

The conductors for the first furnaces of this plant, which were installed a few years ago, were made of closed tubing, but for the more recent units they consist of four parallel connected bars, with the result explained above.

## II—The Self-inductance in Electric Furnace Leads and Means for Reducing the Same

The connections between the transformer and the furnaces are made as shown in Fig. 10. The loop in



which the self-induction takes place is  $a, b, c, d, e, a$ , and this should obviously be made as small as practical conditions will permit, consideration, of course, also being given to copper weight and energy loss. The distances  $bc$  and  $de$  are each, as a rule, approximately 3 m. at least. The question then arises, how can the self-induction in such a small loop, consisting of only one turn, reach such a value as to cause undue difficulties? The inductance  $L$  in itself is not large, but the voltage drop caused thereby,

$$E_s = 2\pi fLI.$$

This is naturally due to the large value of  $I$ , and on the other hand the value seems particularly large when compared to the voltage of the furnace (50 to 100 volts).

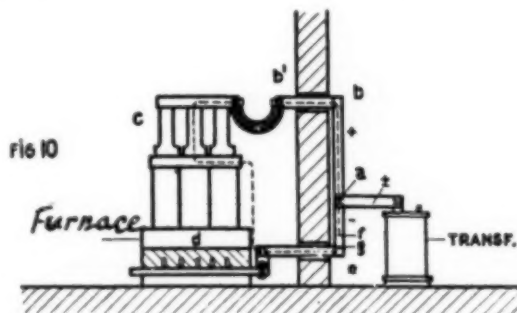


FIG. 10—CONNECTION BETWEEN TRANSFORMER AND FURNACE

By means of the following formulæ, the self inductance of a round conductor forming a circular loop, Fig. 11, can be calculated:

$$L = 4\pi R \left( 0.58 + \log_e \frac{R}{r} - \frac{2r}{R} \right) 10^{-9} \text{ henry}$$

where

$R$  = the radius of the loop in cm.

$r$  = the radius of the conductor in cm.

If, in Fig. 10,

$$bc = de = l = 300 \text{ cm.}$$

$$cd = be = l_1 = 400 \text{ cm.}$$

and if the rectangular arrangement is assumed to be changed to a circular one with the same circumference, its radius will be

$$R = \frac{2 \times 300 + 2 \times 400}{2\pi} = 220 \text{ cm.}$$

If we also assume that the leads are so heavy and so constructed that the radius of an equivalent tubular conductor is

$$r = 12 \text{ cm.}$$

then the self-inductance will be

$$L = 0.934 \times 10^{-8} \text{ henry.}$$

With a current of 18,000 amperes we get

$$E_s = 53 \text{ volts.}$$

For a rectangular loop it is, however, possible approximately to deduce the self-inductance directly as follows: If the self-inductance for the two opposite parallel sides  $l$  are calculated in the usual manner for themselves and similar for the two sides  $l_1$ , it is evident that the total inductance of the loop will be approximately equal to the sum of the two, and thus

$$L = 4 \left( 1 \times \log_e \frac{l_1}{r} + l_1 \log_e \frac{l}{r} \right) 10^{-9} \text{ henry} \\ = 0.934 \times 10^{-8}$$

or (accidentally) exactly the same value as before. This value is, however, too high on account of the fact that the entire side  $cd$ , which comprises the electrodes with their holders and the furnace itself, has a considerably greater cross-section (and consequently greater  $r$ ) than the rest of the circuit. Taking this into con-

sideration and calling the radius (in the equivalent circle) for this side for  $r_1$ , then we get

$$L = 2 \left( 2l \log_e \frac{l_1}{r} + l_1 \log_e \frac{l}{r} + l_1 \log_e \frac{l}{r_1} \right) 10^{-9} \text{ henry.}$$

Assuming

$$r_1 = 40 \text{ cm.}$$

we get

$$L = 0.836 \times 10^{-8} \text{ henry,}$$

and

$$E_s = 47 \text{ volts.}$$

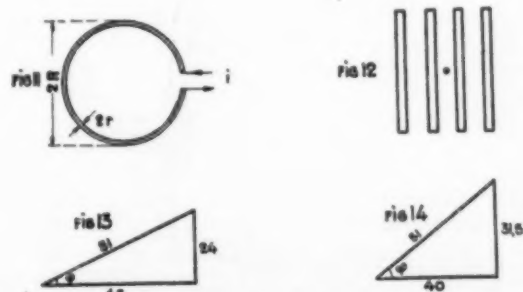
That part of the inductance which is caused by the magnetic field within the conductor itself has been neglected, but when, as previously stated, the current to a greater extent is concentrated near the surface, the error is not appreciable. On the other hand, it may be suspected that the value is too great on account of the fact that the side  $be$  partly consist of cables which are spread out considerably, in which case  $r$ , of course, is greater than assumed even for this part of the loop. Furthermore, these cables sag considerably, which makes the area of the loop less. On account of the many irregularities which the loop presents, it is evident that in general only an approximate result can be expected, and in this particular case possibly a somewhat too large value for the inductance.

### III—Measurement of Resistance and Inductance in Furnace Leads

To measure exactly the effective resistance of the furnace leads in our case seems hardly possible. An endeavor to do this was made and will be explained in connection with the inductance measurements. The matter is, however, not of such a great importance, partly because the losses are not appreciable and partly because of the fact that the conductors should be so arranged as to reduce the skin-effect losses to a minimum.

It is customary to measure the inductance by means of voltmeters, ammeters and wattmeters connected on the primary side of the transformer, in which case the phase displacement on this side may be determined. Knowing the characteristics of the transformer it is then possible to calculate the phase displacement as well as the energy and wattless voltage components in the leads. This requires very accurate and often high-potential instruments with current and potential transformers. On the other hand, the inductance in the furnace leads will be combined with the leakage inductance of the transformer, and the latter must therefore be known in order to determine the former.

The writer has therefore—for both reasons—used another more simple and direct method, consisting in measuring the inductive voltage component of the furnace leads directly with a voltmeter. A pressure wire was placed between the loop conductors, as shown by the dotted line in Fig. 10 as well as in Fig. 12, where the dot represents the relative position of the wire with



FIGS. 11 TO 14—ARRANGEMENTS OF MEASUREMENTS AND VECTOR DIAGRAMS

respect to the copper bars. The potential between the ends *f* and *g* of this wire was determined by a hot-wire voltmeter, which is the only type of meter which can be used within a reasonable distance from the leads on account of their strong magnetic field. This circumstance is also the principal reason for the difficulty to make measurements, as explained above, on the primary side of the transformer, because even there it becomes difficult to place the sensitive instruments so far away as not to be affected by the magnetic fields. Even if the hot-wire instrument is not a precision instrument, it is at least unaffected by these fields and the directness of the method does not involve any appreciable precision.

With the furnace in question, the following values were obtained:

Current in furnace leads = 13,700 amperes.

Voltage at transformer terminals = 51 volts.

Voltage between *f* and *g* = 24 volts.

The current was measured on the primary side of the transformer, also with a hot-wire instrument, and the transformer therefore had to serve as a current transformer in addition.

The voltage triangle is as shown in Fig. 13, so that

$$\cos \phi = \frac{40}{51} = 0.88$$

If the current were 18,000 amperes and the total pressure of 51 volts maintained, the voltage *fg* would be

$$\frac{18,000}{13,700} \times 24 = 31.5 \text{ volts,}$$

and the voltage triangle as in Fig. 14, or

$$\cos \phi = \frac{40}{51} = 0.785$$

which value would apply for our circuit under full load.

One weakness of this measuring method is due to the difficulty in placing the pressure wire just right, in that it cannot, of course, pass centrally through the electrodes and the furnace itself. The inductance voltage will therefore be a little too low, but in any case it may be assumed that measurements with different arrangements of the leads are sufficiently accurate for comparisons.

An endeavor was also made to measure the resistance component of the pressure drop for part of the circuit. This was done by connecting one terminal of the voltmeter to one of the middle bars at *a* (Fig. 10) and the other terminal to an isolated wire, which was inserted between points *a* and *b'* between the bars as before. The other end of this wire was connected to the same bar at *b'*. The potential between the two points of the bar was measured to be approximately 1 volt at a current of 14,000 amperes. In order that this shall repre-

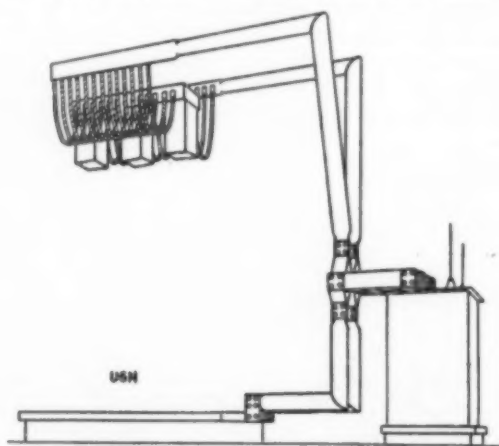


FIG. 15—OTHER ARRANGEMENT OF LEADS

sent the real resistance drop between points *a* and *b'*, it is evident that the sum of all the induced e.m.f.'s in the external as well as the internal voltmeter circuit must equal zero. With the strong magnetic field which is caused both by this particular part of the circuit as well as the other parts of the loop, it is hardly possible that this condition can be exactly met, and as its effect would greatly influence the result, it follows that its exactness would be very doubtful, and consequently the value of this method with respect to measuring the resistance comparatively small.

As previously mentioned, this installation also contained some older furnaces, the leads of which consisted of copper tubing instead of bars. The leads were furthermore divided in two branches (tubes) carried some distance from each other, as shown in Fig. 15. A pressure wire was placed in one of the parallel pipes and the following results obtained:

Current in furnace leads = 18,400 amperes.

Potential at transformer terminals = 50 volts.

Potential between *f* and *g* (Fig. 10) = 22 volts.

The voltage triangle at 18,000 amperes is therefore as in Fig. 16, and

$$\cos \phi = \frac{45}{50} = 0.9$$

As  $\cos \phi$  in the previous case for the same current was 0.785, it is seen that the older method gives considerably better results as far as the inductance is concerned. This depends on the fact that tubes are used instead of the laminated bars, but principally because the lead for each pole is divided in two separate tubes. In these tubes, as follows from the above, the increase in the resistance and the additional losses are considerably less than with laminated bars.

#### IV—Summary

In those parts of the circuit between the transformer and the furnace where the two leads come near together (for example, between the terminals of the transformer and point *a* in Fig. 10), there is no difficulty in keeping the inductance or the effective resistance within reasonable limits; for example, by suitably transposing the positive and negative bars. In such cases where the common distance is relatively great, considerable can be gained by making the leads of two concentric tubes. The inductance as well as the increase in the resistance will thus be a minimum.

In those parts of the circuit, on the other hand, where each pole has a separate path, the use of a single group of laminated bars for each lead would, in general, seem unsuitable, and this especially where large cross-sections are involved. As near as possible to the place where the leads separate, each conductor should be divided into two groups, placed sufficiently far apart with respect to the length. With not an altogether too great current, each of these groups may consist of a single bar whose thickness should not exceed 15 to 20 mm. If the current is great, so that for practical reasons a total thickness of the bars for each group of more than 20 mm. would have to be used, tubes should preferably be used instead of bars. Otherwise the arrangements should be as stated above—that is, two tubes for each pole should be used, placed a suitable distance from each other and with a thickness of the walls from 15 to 20 mm. In general, a greater diameter of the tube (and consequently a less thickness of the walls) as well as a greater distance between the groups will give a better result in regard to the inductance as well as to the increased resistance.

It has been the aim to show a method, even if only



approximate, to measure directly the self-inductance and phase displacement of the low-tension furnace leads of a completed installation by means of simple apparatus.

## Impurities in Electrolytic Copper Refining

By Lawrence Addicks

Electrolytic refining gives a triple separation of the various impurities in a blister copper anode, distributed in the anode slimes, the electrolyte and the cathode. The chief object of the process is, of course, to make a pure cathode, and secondarily to keep impurities from mounting too high in the electrolyte, in order to keep the cost of purifying the electrolyte within reasonable limits. The ideal process would, therefore, send all of the impurities into the anode slimes, which would then be worked up into various by-products, and the electrolyte would stay of a constant composition. Practically a considerable proportion of the impurities dissolve in the acid sulphate electrolyte, and steps have to be taken for systematic purification of the solution.

Both the problem and the means of dealing with it have greatly changed in the last twenty years. Two decades ago, when electrolytic refining was in its infancy, there were large quantities of black copper to be treated, and many of the smelters were producing pig high in arsenic. An idea of this situation may be gained from some representative analyses of pig copper of that period, given in Table I:

TABLE I—SOME PIG COPPERS ELECTROLYTICALLY REFINED IN 1901

Brand	Arsenic	Antimony	Iron	Sulphur	Lead	Copper
Argentina .....	0.46	0.40	0.03	0.15	.....	96.5
Chicago .....	0.30	0.19	0.22	.....	1.72	96.0
Germania .....	2.92	0.17	0.01	0.07	.....	95.0
Philadelphia .....	0.86	0.08	None	Trace	.....	96.2

This whole situation was changed when the strongly reducing action of the black copper furnace and the practically neutral atmosphere of the copper-producing reverberatory were supplanted by the strongly oxidizing Bessemer converter, and the widespread use of sulphur as a carrying agent for copper brought nearly the whole production through a process which efficiently removed most of the objectionable impurities.

On the other hand, some imported copper pig is of less than standard purity, and there is a steadily increasing production of secondary copper from plants treating junk by the old processes, and they often produce very foul pig. Some representative analyses of these various classes are given in Tables II, III, IV:

TABLE II—ANALYSES OF SOME EXAMPLES OF SECONDARY PIG

Brand	Arsenic	Antimony	Sulphur	Iron	Nickel	Lead	Copper
A	0.03	.....	0.94	0.92	0.35	5.49	85.0
B	0.03	0.05	1.02	0.36	0.32	2.68	84.8
C	0.05	0.19	.....	0.93	0.47	5.25	82.4
D	0.05	2.25	Trace	Trace	None	12.79	82.6
E	0.05	0.41	.....	5.65	1.58	2.02	.....
F	0.05	2.63	0.75	5.53	0.33	2.36	84.9

TABLE III—ANALYSES OF SOME FOREIGN PIG COPPER

Country	Arsenic	Antimony	Sulphur	Iron	Nickel	Lead	Copper
Chili .....	0.10	0.01	0.74	0.99	0.22	0.03	97.4
Japan .....	0.18	0.12	0.39	0.03	0.06	0.83	97.6
Peru .....	0.13	0.20	.....	0.03	Trace	.....	.....
Spain .....	0.11	.....	0.69	1.03	0.02	0.13	97.7

TABLE IV—ANALYSES OF NORMAL BLISTER COPPER

Country	Arsenic	Antimony	Sulphur	Iron	Nickel	Lead	Copper
Australia .....	0.001	0.011	0.224	0.029	0.047	0.603	99.30
Canada .....	0.037	0.045	0.090	0.050	0.411	0.002	98.80
Mexico .....	0.017	.....	0.260	.....	0.040	.....	.....
South America .....	0.007	.....	0.188	0.037	0.044	0.028	99.20
United States .....	0.008	0.006	0.045	0.034	0.037	0.007	99.30

We have, therefore, the general problems of keeping the impurities out of the refined copper and of working up such of the impurities from the anode slimes and the electrolyte as may show a commercial profit.

The early refineries had much trouble with even the first leg of this proposition, and the uncertainty as to the chemical purity of electrolytic copper produced in the early days had much to do with the premium established in favor of Lake Copper. Arsenic was the chief enemy, and its elimination from the electrolyte became the main metallurgical problem of the plant.

This situation brought about the development of a by-product bluestone plant, fed by systematic withdrawals from the electrolyte, the final mother liquors being precipitated upon iron and discarded.

Then the flood of incoming arsenic abated, and in some cases nickel became the major impurity, bringing about the development of the by-product nickel sulphate plant, the mother liquors being returned to the electrolyte.

In general, one of these two methods of control of the composition of the electrolyte have been used, and they will be examined more or less in detail later on.

The anode slimes were at first cupelled with lead, and only the silver and gold recovered, these being parted by sulphuric acid. Later, lead practice was discarded, except by those plants operated in conjunction with a lead refinery, and much work has been done upon the recovery of selenium, tellurium, platinum, palladium, arsenic, antimony, bismuth, etc. A quite complicated pyro-metallurgy, followed by electrolytic parting, has been developed, and much research devoted to the possibilities of a full wet process.

A discussion of the general question of impurities, therefore, falls under six main headings, namely: (A) sources, (B) exits, (C) distribution, (D) chemical requirements of refined copper, (E) recovery of soluble impurities from the electrolyte, and (F) recovery of insoluble impurities from the anode slimes.

### A—Sources

Apart from the entering pig copper there are as many sources of impurities as there are supplies entering the process. While, of course, many of these sources are quite negligible, some are of sufficient magnitude to be worthy of consideration. Among these are fuel, fluxes and acids.

Fuel enters the process at various stages, but the only place where it is of account in this discussion is in the melting of cathodes. Here the various products of combustion and particularly the sulphur have to be reckoned with, as sulphur is one of the principal impurities in refined copper. The discussion of this question falls more normally under the head of chemical impurities in refined copper.

Fluxes include, by a somewhat liberal definition of the word, the materials of which the furnaces are made insofar as they enter the metallurgical slags, the true fluxes, such as limestone and pyrites cinder added in the retreatment of these slags, the charcoal or other carbonaceous covering used to protect molten copper from undue oxidation, bone ash or similar material used to "butter" the molds, and soda nitre and soda ash used as fluxes chiefly in the treatment of the anode

slimes, and the antimonial lead with which the tanks are lined.

Under acids we have sulphuric, nitric and hydrochloric, the last sometimes as sodium chloride. The sulphuric acid is added to make up losses of free acid in the electrolyte in the copper electrolysis and the nitric similarly in the parting plant. The chloride is added to the copper electrolyte chiefly to precipitate antimony as oxychloride, although it has been claimed by many to have positive value as an addition agent.

Fortunately most of these process supplies carry but little in the way of metallurgical impurities. The notable exceptions are blast-furnace fluxes, sodium salts and sulphuric acid.

As refinery slags are always strongly acid, being made by a union of metallic bases with siliceous furnace material, it is necessary to find lime and iron to replace the copper in these slags. The natural source of iron in the vicinity of most refineries is pyrites cinder resulting from the manufacture of sulphuric acid. As arsenic is commonly associated to a greater or less degree with iron pyrites, more or less of this element may be introduced in this manner.

In the same way sulphuric acid made by burning pyrites is likely to contain considerable quantities of arsenic as an impurity, and unless purified acid is used it may be a heavy contaminating agency, since where sulphate salts are made as a by-product the acid purchases are large.

In like manner any nitrate of soda used in the silver building boiling tanks as an oxidizing agent or sodium chloride added to the electrolyte directly bring about a concentration of sodium sulphate which may be objectionable.

### B—Exits

A complete analysis of what may be called "exits" for impurities was given in the article "Sources of Metal Loss in Copper Refining" (METALLURGICAL AND CHEMICAL ENGINEERING, July 1, 1916). Based on this, eliminating such items as do not bear directly on our immediate problem, we may classify the exits as (a) outgoing commercial products, (b) slags and (c) stack gases.

The ideal process would eliminate the two latter products entirely and send all of the impurities out as commercial products. Practically not only do several elements escape in their entirety, but excepting copper, silver and gold, the remaining are recovered at far from 100 per cent efficiency.

The tendency to-day is to check stack losses so that in time there will be but two outlets, the one to commerce and the other to the slag dump.

When markets are unsatisfactory some of the products can be stored, as has already been the case with selenium, tellurium and bismuth.

### C—Distribution

The distribution of impurities depends partly upon their chemical characteristics and partly upon the metallurgical practice of the individual plant.

In the first place, the cathode will contain measurable quantities of all impurities found in the anodes, although there is room for some discussion as to what proportions of these arrive by electrolytic deposition, by inclusion of electrolyte and by mechanical contamination by anode slimes. (See Addicks, Trans. Am. Electrochem. Soc., vol. xxvi, p. 51.) The percentage of anode impurities found in the refined copper may be seen by direct comparison of average analyses over a long period of operation, as in Table V.

The four elements showing a cathode recovery of

TABLE V—METALLURGICAL EFFICIENCY OF REFINING

Element	Anode	Wirebar	Per Cent of Original Impurity	Efficiency of Refining
Copper.....	99.030	99.939	.....	.....
Silver.....	0.1687	0.00131	0.78	99.22
Gold.....	0.0051	0.000013	0.25	99.75
Sulphur.....	0.0075	0.0029	38.60	61.40
Nickel.....	0.3200	0.0037	1.15	98.85
Lead.....	0.0597	0.0020	3.32	97.13
Arsenic.....	0.0523	0.0015	2.87	91.68
Antimony.....	0.0409	0.0034	8.32	99.47
Bismuth.....	0.0051	Trace	.....	99.41
Tellurium.....	0.0282	0.00015	0.53	83.90
Selenium.....	0.0682	0.00040	0.59	.....
Iron.....	0.0181	0.0039	16.10	.....

over 99 per cent are silver, gold, selenium and tellurium, none of which dissolve in the electrolyte. Therefore, the mechanical contamination by anode slimes is less than one per cent. Then we have nickel at 1.15 per cent; this element, while present in oxidized form in the slimes, goes chiefly into solution as sulphate. The same is true of arsenic which, however, forms a light slime which readily attaches itself to the cathode. Lead comes not only from the anodes but from the tank linings, so that the efficiency is not quite true in this case. The same is true in lesser degree of antimony, as hard lead is universally used to-day for tank linings. Antimony is further precipitated from the electrolyte as oxychloride, as previously described, entering the float slime. A characteristic analysis of this sediment is given in Table VI.

TABLE VI—ANALYSIS OF FLOAT SLIME

Element	Per Cent
Copper.....	3
Arsenic.....	13
Antimony.....	30
Bismuth.....	8
Silver.....	4
Iron.....	0.3

When we come to consider the efficiency of refining with regard to iron and sulphur we must remember that both these elements are introduced in the melting of the cathodes, the former in the rables and tools used and the latter in the fuel and ladle charcoal, and we also have sulphate sulphur from the electrolyte, so that the figures are misleading.

We may say in a general way, therefore, that the efficiency of refining is very high and that the cathode copper offers a very small outlet for anode impurities; further, that the great bulk of those impurities which are soluble in dilute sulphuric acid will concentrate in the electrolyte.

The balance of the impurities must go into the slimes and we can attempt a measure of this by comparing the assays of the anodes and of the raw slimes as they come from the tanks except for boiling free of soluble salts. This is done in table VII.

The last two columns of table VII assume that 99.5

TABLE VII—CONCENTRATION OF ANODE IMPURITIES IN SLIMES

Element	Anode, per Cent	Slimes, per Cent	Per Cent Anodes x84.4	Per Cent Recovered
Copper.....	98.14	14.3	.....	.....
Silver.....	0.417	35.0	35.2	99.5
Gold.....	0.00711	0.643	0.600	(107)
Nickel.....	0.314	5.25	26.5	19.8
Arsenic.....	0.236	2.68	19.9	13.5
Antimony.....	0.0906	5.35	7.6	70.0
Bismuth.....	0.0088	0.46	0.74	61.9
Sulphur.....	0.0037	1.69	0.31	(541)
Iron.....	0.0123	0.17	1.04	16.4
Lead.....	0.0456	2.44	3.85	63.4
Selenium.....	0.0479	5.70	4.04	(112)
Tellurium.....	0.0318	2.69	2.68	(100)
Zinc.....	0.0100	Trace	0.84	None
Insoluble.....	0.1213	6.60	10.2	64.5



per cent of the silver was in the slimes the remaining 0.5 per cent being in the cathodes. On this basis the recovery in the slimes of the remaining elements has been calculated. Of course, the gold, selenium and tellurium should also show a recovery of about 99.5 per cent, and the discrepancies simply indicate that the correspondence between identity of slimes and anodes is not quite exact.

The sulphur shows a large excess due to the fact that the sulphur in the sulphuric acid of the electrolyte has combined with some of the impurities as sulphates which have not proved readily soluble.

Nickel, iron, zinc and arsenic, as would be expected, show small recoveries; the first three form readily soluble sulphates and arsenious acid is quite soluble in the electrolyte. Nevertheless, with the exception of zinc the slimes retain some of even these elements.

Lead which has a but slightly soluble sulphate, antimony, which is precipitated as oxychloride, bismuth and siliceous matter show high but not perfect recoveries.

Much of this group goes into the float slime which is largely separated out before the heavy slimes are sent to the silver building and this, if corrected for, would make a nearly complete slime recovery.

An analysis of the electrolyte corresponding to the example given above would be about as stated in table VIII.

TABLE VIII—REPRESENTATIVE ANALYSIS OF ELECTROLYTE

Specific gravity	1.226
Per cent free acid	12.03
Per cent copper	2.94
Per cent nickel	1.48
Per cent chlorine	0.0031
Per cent arsenic	0.913
Per cent antimony	0.0350
Per cent iron	0.060
Per cent bismuth	0.0026
Per cent zinc	0.0166
Per cent alumina	0.0595
Per cent calcium sulphate	0.1348
Per cent magnesium sulphate	0.0370
Per cent sodium sulphate	0.5048

A comparison of the relative values of the impurities in the electrolyte with those in the anodes confirms in a general way the distribution already shown. It is evident that in this particular case nickel is the controlling impurity and that any system of purification of the electrolyte which will hold this element at the desired concentration will automatically take care of arsenic and other impurities.

#### D. The Requirements of Refined Copper

This subject is of sufficient importance to be reserved for treatment at length in a future article.

#### E. Purification of the Electrolyte

Any system of purification must regularly withdraw sufficient electrolyte to control the amount of the chief impurity. For example, in the analysis given in table VIII, nickel is the element which would first grow to undesirable concentration, although arsenic is a close second and the maximum allowable values of various elements depend upon conditions under which an individual plant is operating. Both nickel and arsenic have been allowed to reach 3 per cent in the electrolyte without disaster in certain local and temporary cases. The first thing is therefore to ascertain what quantity of electrolyte must be daily withdrawn.

#### I. PURIFICATION BY CEMENTATION UPON IRON

The early methods of purification consisted simply in cementing the copper upon iron and throwing the copper-free liquor away. The scrap iron would be piled in a lead-lined tank, the liquor run in and brought to a boil by heating with steam and at the end of an hour

a bright iron rod would not tarnish when introduced, indicating complete precipitation of the copper. The liquor was then run to the sewer and occasional clean-ups of cement copper made.

Theoretically but 0.88 lb. of iron is required to replace one pound of copper. In this case, however, the scrap contained more or less inert graphite and iron oxide, the iron precipitated more or less arsenic, etc., and the high free sulphuric acid actively attacks the iron so that as much as two pounds of scrap iron are often required per pound of copper precipitate.

The cement is generally quite foul running about as shown in table IX:

TABLE IX—ANALYSIS OF TYPICAL CEMENT FROM DISCARDED ELECTROLYTE

Copper, per Cent	Iron, per Cent	Arsenic, per Cent	Silver, Oz. per Ton	Gold, Oz. per Ton
70	5	10	15	0.1

The silver and gold come, of course, from suspended slimes carried over from the electrolytic tanks.

While this method has the advantages of simplicity in operation and small plant required, it makes a foul cement which requires retreatment, runs up a heavy bill for scrap iron and entirely wastes both the free and combined sulphuric acid content of the electrolyte.

Nevertheless, it is still used in some small plants, and is always considered a legitimate emergency measure for dealing with a bad electrolyte.

#### II. THE BY-PRODUCT MANUFACTURE OF BLUESTONE

The next purification method developed was to go into the manufacture of commercial bluestone, using electrolyte as a raw material. The process consisted of four steps, as shown in Fig 1: Neutralization of free acid by means of anode copper, concentration of neutral liquor by boiling, crystallization of heavy liquor, and cementation of mother liquors.

In this way the entire free acid content as well as that already combined with copper in the electrolyte is recovered as sulphate of copper except that discarded in the final mother liquors.

In this way the iron tanks do not receive any liquor until the impurities have risen to a point where bluestone of commercial purity can no longer be made by fractional crystallization.

Also, as anode copper is used for neutralizing the free acid a certain amount of copper is refined, the silver and gold remaining as slime in the shot towers, and

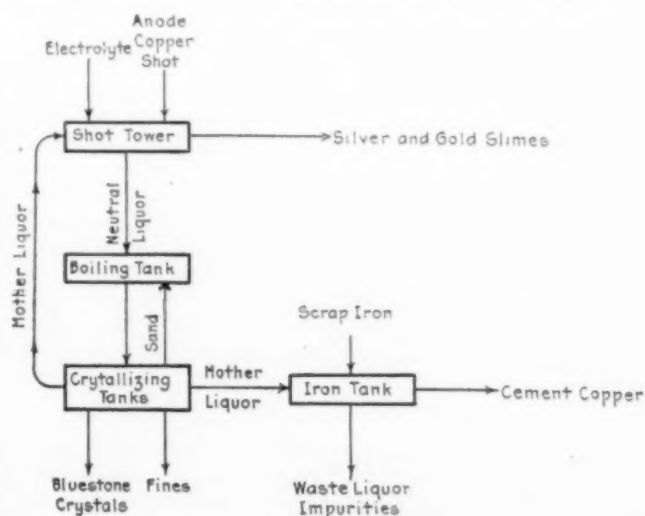


FIG. 1—BY-PRODUCT BLUESTONE PLANT

therefore the by-product plant is entitled to a certain amount of tolls to be credited against its operating expense.

Then there is still the legitimate profit from the market price of bluestone, so that it is possible to place the purification system on a revenue-producing basis.

On the other hand, the plant required is bulky, it is dependent for results upon the market for bluestone which at times is badly overproduced and finally the plant is strictly limited to a predetermined capacity, and therefore uses the electrolyte as a reservoir for fluctuating amounts of anode impurities. Also where very foul anodes are to be treated the bluestone plant becomes enormous.

However, as this system is more or less used to-day, though generally in addition to other methods, some account of the process will be given.

### 1. Capacity

A building 50 ft. by 150 ft. ground plan will produce about 140,000 lb. of bluestone a month. This is equivalent to about 35,000 lb. of copper, but about three-quarters of this comes from the shot copper and only 9000 lb. is from the electrolyte, so that this plant would represent the withdrawal of but 100 cubic feet a day of electrolyte.

### 2. Shot Towers

Copper is not readily soluble in dilute sulphuric acid, especially in the presence of various impurities. In order to promote the rate of solution the liquor is heated and poured over the copper intermittently so as to promote the oxidation of the copper. The towers are built in various ways in order to accomplish this, but the simplest method is to spray the hot liquor over the top of the bed and let it trickle through.

The copper itself is cast in the form of so-called shot in order to increase the surface exposed. Shot is a mass of small hollow irregular spheres, and as these dissolve away, the mass crumbles and this tends to prevent packing. It is made by adding a little matte to an anode furnace charge to lower the pitch and then pouring a thin stream of metal through a blast of air into a well filled with water. More or less minor explosions occur, but if the procedure is skillfully carried out the result is a surprisingly light mass of detached globules ranging from  $\frac{1}{4}$  in. to  $1\frac{1}{2}$  in. in diameter.

Underneath the shot towers is a well, and here the silver and gold slimes wash down as the copper is dissolved and settle out. These are periodically collected and sent to the silver refinery to be smelted along with the anode slimes from the electrolytic tank house. It is impossible absolutely to neutralize the free acid in the electrolyte in this way in a reasonable time, but by repeated circulation at high temperature it is possible to bring it below 1 per cent. The temperature must be above 150 deg. Fahr. for effective work, and the time required is from four to seven days in a plain tower.

### 3. Boiling Tanks

The boiling tanks are lead-lined open tanks with closed steam coils and the liquors from the shot towers are here concentrated as far as steam at a reasonable pressure for lead pipes will carry them. This is about 38 deg. Beaumé and corresponds to 9 or 10 per cent copper. The time required for a batch is about eight hours.

### 4. Crystallizing Tanks

The crystallizing tanks are shallow, open, lead-lined tanks provided with strips of lead hung from cross bars on which the crystals grow. The liquor from the boiling tanks is allowed to stand quiescent in these tanks for five days, which time experience has shown to be

the best. A longer period results in more or less resolution, while forced cooling by means of cooling coils results in a crop of small and less pure crystals.

The choice large crystals grow chiefly as trees on the lead strips. At the bottom of the tanks a mass of fine crystals forms.

The crystals are removed after the mother liquor has been pumped out and are then generally dried by hot air and screened to separate the coarse and fine, each class being packed in barrels for shipment. The fine sand is sent back to the boiling tanks and recrystallized.

The best crystals physically are made from truly neutral liquor. Should the liquor carry 2 per cent acid or over, the crystals are likely to be hygroscopic and are not a prime market product. Also calcium sulphate, if present in the liquor to any extent (this salt is sparsely soluble in such solutions), will form white "whiskers" on the crystals.

The main physical question is, therefore, to obtain a maximum proportion of large, clean, dry crystals. An ordinary yield is 47 per cent large crystals, 9 per cent pea and 44 per cent sand.

Chemically the problem is to keep the mother liquor down in impurities to a point where fractional crystallization is sharp enough to make a commercial salt. The alternative is to dissolve and recrystallize. The effect of recrystallizing is shown in table X, where "bottoms" have been dissolved and crystallized, forming crystals and a second crop of bottoms, but leaving most of the arsenic and antimony behind in the new mother liquor.

TABLE X—REMOVAL OF IMPURITIES FROM BLUESTONE BY RECRYSTALLIZATION

	Per Cent Arsenic	Per Cent Antimony
Original "bottoms".....	0.434	0.113
New crystals.....	0.076	0.013
New bottoms.....	0.117	0.014

$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  contains approximately 25.4 per cent copper, 38.5 per cent combined acid and 36.1 per cent water of crystallization. Ninety-nine per cent crystal should, therefore, run slightly better than 25 per cent copper and 98 per cent slightly less and bluestone is generally considered to carry one-quarter copper. In table XI are given some random analyses of the products from several plants.

TABLE XI—REPRESENTATIVE ANALYSES OF BLUESTONE

Source	Remarks	Per Cent Copper	Per Cent Iron	Per Cent Nickel	Per Cent Arsenic	Per Cent Antimony
A	Coarse	24.97	0.195	0.358	0.018	0.006
A	Fines	24.72	0.215	0.419	0.040	0.009
A	Seconds	23.25	0.250	1.250	0.090	0.017
B	"Anhydrous"	26.18	0.600	1.850	0.668	0.030
C	Coarse	25.22	0.025	0.105	0.003	0.005
D	Coarse	24.80	Trace	.....	0.150	0.018

The wide range of the impurities in the different products in table XI is due chiefly to the difference in the electrolytes at the various plants. The salt showing 26.18 per cent copper had been overdried, thereby losing some of the water of crystallization; this makes a dirty white crystal and is also a source of loss to the producer, as copper contents above the guaranteed amount are not paid for.

### 5. Mother Liquors

The mother liquors from the crystallizing tanks are returned to the boiling tanks and reconcentrated with fresh liquor from the shot towers. As the impurities grow in concentration, however, the bluestone is in-



creasingly contaminated and a point is reached where a proportion has to be diverted to the iron tanks to be worked up into cement copper.

Sometimes a foul copper-nickel-iron sulphate is crystallized from such liquors before cementing. An example of such a salt is shown in table XII:

TABLE XII—COPPER, NICKEL, IRON SULPHATE FROM MOTHER LIQUOR

Per Cent Copper	Per Cent Nickel	Per Cent Iron	Per Cent Arsenic	Per Cent Antimony	Oz. per Ton Silver
9.52	11.50	1.19	0.23	0.024	0.15

The silver is, of course, due to contamination by suspended slimes from the shot towers. Similar quantities and a proportionate amount of gold is found in bluestone when anode copper is used for shot. A salt of this character has no commercial use, but is a good starting point for nickel recovery as another by-product.

### III. PURIFYING WITH INSOLUBLE ANODE TANKS

Where but little nickel is present and arsenic is the predominant impurity, a simple process based upon the use of insoluble anode tanks is sometimes employed.

A certain amount of electrolyte is diverted to a set of tanks provided with lead anodes and operating in cascade so that practically all of the copper and arsenic are plated out and the equivalent sulphuric acid is liberated. The treated liquor is returned to the electrolyte.

This uses a considerable amount of power, but recovers the acid and calls for no scrap iron. It takes three tanks in cascade to bring the copper and arsenic down to 0.1 per cent or less. The first tank will operate at about 85 per cent current efficiency and produce cathodes, which may with reasonable safety be included in the fine copper output; the second will run at perhaps 50 per cent efficiency and the cathodes reserved for casting copper or anode changes; the last tank runs at a very low copper efficiency and produces a sludge consisting of about half copper and half metallic arsenic. Much of the latter can be eliminated from this by roasting and sublimation, if desired. Such insoluble anode tanks evolve arseniuretted hydro-

gen, which is very poisonous, and they should therefore be located out of doors.

This method is limited by the permissible amount of impoverishment of the electrolyte in copper; if carried to extremes it is evident that the whole copper content of the electrolyte would be withdrawn, the acid being correspondingly increased. On the other hand, when nickel is practically absent from the anodes and the copper withdrawals necessary to hold down the arsenic do not exceed the normal growth of copper in the electrolyte, it is a satisfactory solution of the purification problem.

### IV. COMPLETE CYCLICAL PURIFICATION

The method of purification of the electrolyte in general use among copper refineries to-day is shown in diagrammatic form in Fig. 2. Electrolyte is diverted to insoluble anode tanks at a rate just sufficient to keep the determining impurity at the desired point. This impurity is almost always nickel or arsenic and generally the former.

The first step in the process is the same, therefore, as that just described in the preceding paragraph, but the liquor resulting therefrom instead of being returned to the electrolyte is sent to a steam boiling tank where it is concentrated as in the manufacture of bluestone up to about 40 deg. Beaumé.

The liquor is then transferred to a tank made of boiler plate, as, being nearly copper-free and of high sulphuric acid content, it is no longer seriously corrosive to iron. This evaporator is heated by direct fire until the syrup reaches about 70 deg. Beaumé, at which strength practically all the impurities except the small amount of arsenic which has escaped the insoluble anode tanks and the sodium and potassium salts have been precipitated as anhydrous sulphates.

This heavy liquor with its suspended solids is then tapped on to a sand filter where the bulk of the strong acid is filtered out. The mushy salts are then shoveled on to a draining board and finally into a sucking tub, where the acid is displaced with a very small quantity of water.

The partly washed salts are then shoveled on to a drying floor where the water is gradually taken up as water of crystallization and the mass sets into lumps of partially hydrated sulphate, which may be readily handled and shipped and is in good physical shape for charging into a furnace for the recovery of metal values.

If the strong acid filtrate is chilled before returning it to the electrolyte much of the sodium sulphate will be thrown out. Practically this occurs at ordinary winter temperatures at most of the plants.

This process is completely cyclical except for the combined acid sent out with the crude nickel salts and such acid losses as may be incurred by fumes from the fire evaporator. The nickel is recovered in a form reasonably acceptable to a nickel smelter; but little low-grade cathode copper is made, and the arsenic could be separately recovered were it worth while to do so.

The objection still applies that the electrolyte may be robbed of too much copper and this has especial force when discussing nickel, as much of the anode nickel appears to dissolve electrochemically so that more copper is plated out at the cathode than is electrochemically dissolved at the anode.

The remedy, in case of trouble of this character, is to build shot towers and allow a certain proportion of the regular electrolyte to trickle through them. As the solution so diverted has always high free acid content, such towers are more active than in a bluestone plant, where complete neutralization is the object.

The chemical separations are not sharp and some lee-

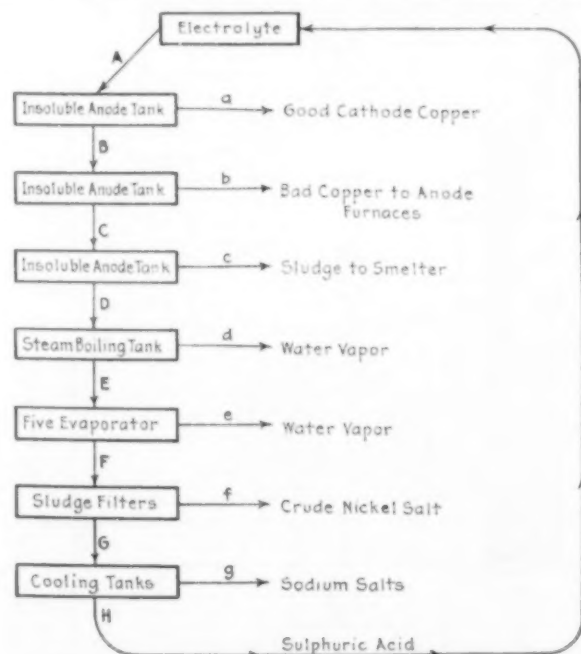


FIG. 2—MODERN METHODS OF PURIFICATION OF ELECTROLYTE

way has to be left for circulating impurities due to this fact. An example of crude nickel salt made in this way is given in table XIII:

TABLE XIII—ANALYSIS OF CRUDE NICKEL SALT

Per Cent Water	Per Cent Copper	Per Cent Iron	Per Cent Nickel	Per Cent Arsenic
17.0	0.57	1.76	28.45	0.02

#### F. Recovery of Insoluble Impurities from the Anode Slimes

This question involves the whole metallurgy of the silver refinery and this will be taken up separately in another article.

### The Testing of Lubricating Oils

By Hugh K. Moore and G. A. Richter

The selection of the most suitable lubricating oil for plant operation depends upon three things: the specific conditions under which this oil is to be used, the cost of the lubricant and the cost of power.

A lubricant which is ideal for one specific purpose may be entirely unsuitable for service with another type bearing, or may prove very uneconomical in another plant where the cost of power is different. The characteristics of the oil which determine its suitability may be ascertained in many ways, but there is no one machine which will combine all the characteristics to be considered and allow a general conclusion to be drawn regarding its net value.

As inferred above, the significance of test results made on lubricating oils depends entirely upon the "type" of lubrication under consideration, and conversely, the particular form of lubrication which is of immediate interest determines the test methods by which one selects the oil most suitable. Often, depend-

ing on the price of power and price of oil, it is wise not to use the best grade of oil to realize most economical results. Many test machines have been designed and built for testing the physical properties of lubricating oils, each serving the particular purpose of the designer.

The experiments and tests which we will refer to in this article were conducted with a type of bearing which measures relatively the durability and also the internal friction or "power consumption" of the oil in question. The apparatus as employed in these tests aims to duplicate that type of bearing in which the oil is present in excess.

A photograph and sketch of this machine are shown in Figs. 1 and 2. It consists essentially of the bearing cone A which is rotated within the conical sleeve B, the desired pressure being maintained by a suspended weight W on the shaft C. The machine is operated by means of a  $\frac{1}{2}$ -hp. direct-current motor through a gear drive. The conical sleeve is made high enough to use cones of different size and is jacketed in order to maintain any desired temperature either high or low at the bearing surface, and also to provide means for bringing the temperature of the bearing to any selected temperature just previous to each successive run in a series.

The power consumption or friction during the operation is measured by means of ammeter and voltmeter. Knowing the efficiency of the motor, the results obtained by using different lubricating oils in the conical bearing become directly comparable. This comparison may also be realized by operating each time with a predetermined power input. The motor bearings and gear drive are kept lubricated with a large excess of the same lubricant all the time, and thus this factor is practically eliminated.

Provision is made for several different methods of testing the oil in question. The revolving cone is furnished with a spiral feeding groove through which the oil may be brought to the bearing surface. The shaft supporting the weights is hollow and allows the oil after feeding through the bearing groove to travel down to a small oil pump which pumps the oil back into the conical bearing, thus completing the cycle. During this operation the desired readings are taken. If the temperature rise of the bearing is of essential importance, a thermometer is suspended in the excess oil over the

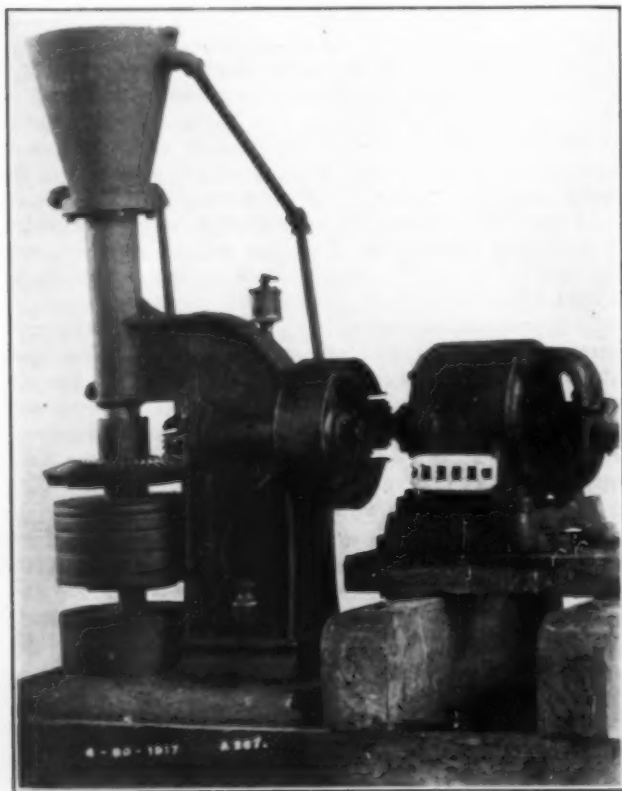


FIG. 1—TEST MACHINE

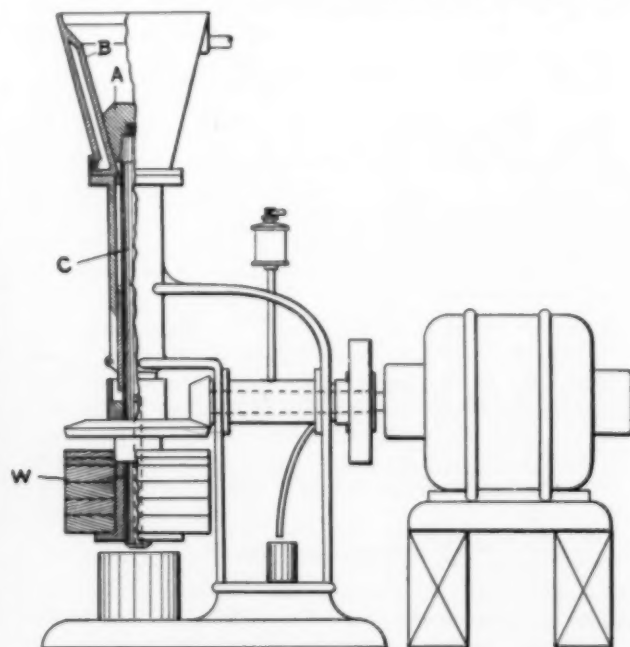


FIG. 2—DIAGRAM OF TEST MACHINE



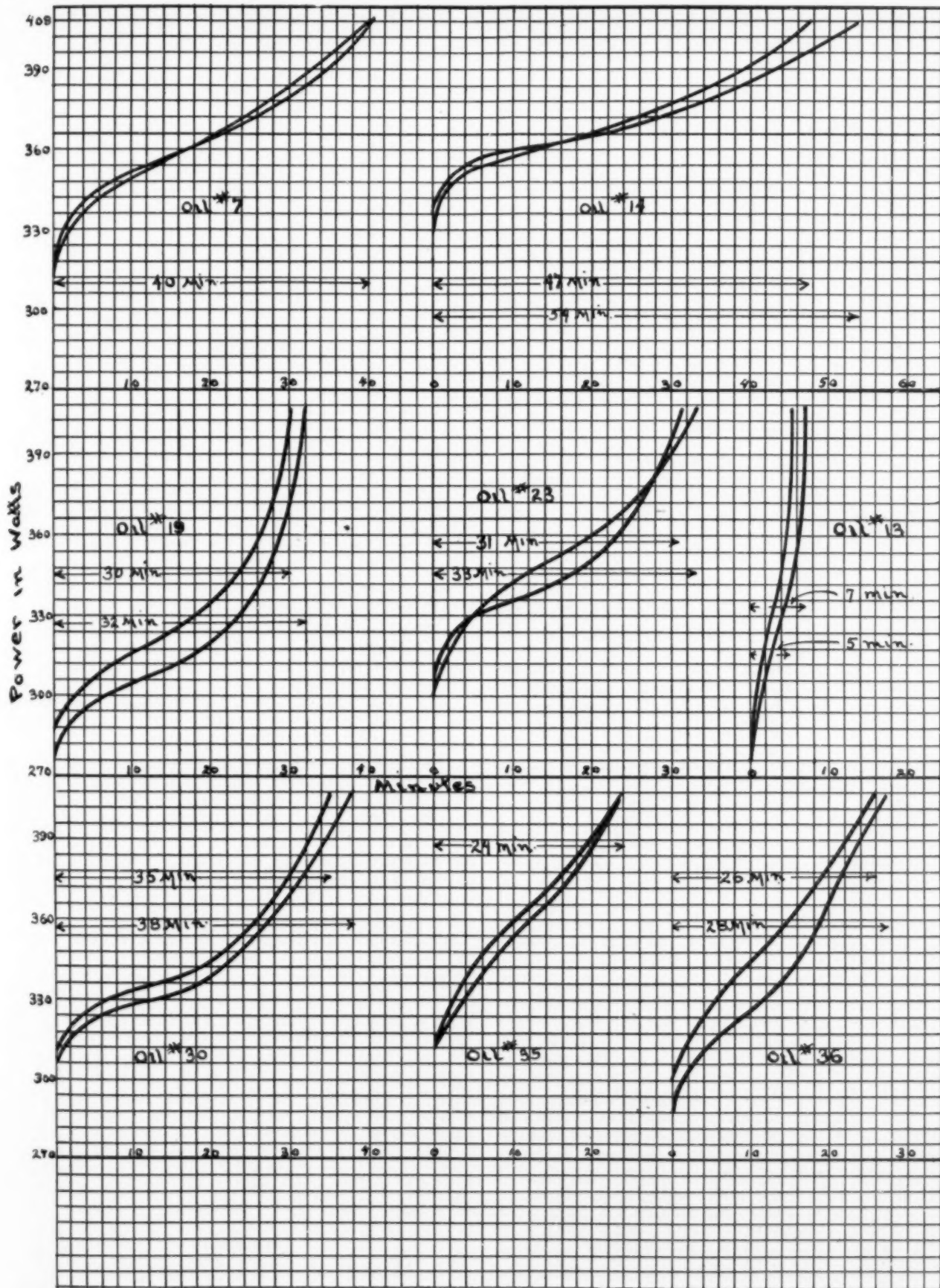


FIG. 3—SUMMARY OF CURVES

bearing. Where the power consumption is the determining factor, the input in watts is plotted against time. In this way the "durability" or "breaking down" qualities of the oil may be studied. If the specific case of

lubrication which is being duplicated assumes a given constant temperature, this temperature may be realized by means of the jacket about the bearing. Moreover, the speed, pressure of bearing, and material of

the bearing, may be varied at will to suit the case in question. In carrying out tests as indicated above the authors record:

Material of bearing.  
Speed of shaft.  
Pressure per square inch.  
Type of lubricant.  
Initial temperature.  
Final temperature.  
Curve—power vs. time.  
Curve—temperature vs. time.

A second method which may be employed in testing the oil consists in eliminating the oil pump and dropping the lubricant onto the bearing as needed. The oil is regulated by keeping the power input below a predetermined limit and the oil per hour is thus obtained. In carrying out such a test, the lower end of the oil groove in the bearing is first plugged so as to keep the oil from escaping through the groove. A drop of oil is added to the dry bearing and the machine started. When the electrical instruments show the predetermined maximum power input, another drop is added, and the machine allowed to continue to operate until the same maximum power input is registered. The consumption of lubricant per unit time is the basis of comparison.

A third method which may be used in testing the lubricant is to plug the lower end of the groove as before, start the machine without the circulating oil pump, add a certain amount (3 cc.) of oil to the bearing, and record the power input each minute. The machine is allowed to run until a maximum allowable power input is reached, and the power is plotted against time. By studying such a curve one can obtain valuable information regarding the internal friction (power consumption) and also the durability of the oils in question. The authors, for the most part, have employed the last mentioned method of using the machine, although the other methods were also used to advantage.

In carrying out the specific series of runs to be described the operating conditions were as follows: The bearing cone had a vertical angle of 30 deg. The lower end of the feeding groove was plugged with solder. A weight of 100 pounds was attached to the shaft, thus realizing a normal bearing pressure of 1.5 lb. per sq. in. The shaft was operated at a speed of 80 r.p.m. The set includes a series of 8 types of machine oils obtained from different companies. Each run was carried out as follows: The machine was started and three cubic centimeters of the given oil added to the bearing, power readings were taken and continued at intervals of one minute. In this particular series the amperage of the motor was allowed to reach 3.4, whereas the voltage was kept constant at 120 volts. At the end of each run the bearing was cooled to the same starting temperature of about 20 deg. C. by running cooling water through the jacket of the conical sleeve. Several runs were made on each oil for check results. It is to be noted that the absolute number of minutes which is required for the power to reach the above limited amperage is not the only measure of the true value of the oil. To determine the most suitable oil the curves must be plotted and studied with care. The data and curves are given in Table I and Fig. 3.

It is of interest to note that the oil which stands up for the longest period of time without exceeding the allowable power consumption requires a comparatively higher power input during that interval of operation than do the other oils which reach the same predetermined maximum in shorter time. This indicates that although the one oil possesses greater durability, most of the other oils require a much smaller power consumption during their time of operation. Before

Number of Oil	Initial Temperature, Deg. C.	Final Temperature, Deg. C.	Temperature Increase, Deg. C.	Time in Min., Run I	Time in Min., Run II	Average Time
7.....	24.0	36.5	12.5	40	40	40.0
13.....	26.5	30.5	4.0	5	7	6.0
14.....	22.0	38.5	16.5	47	54	50.5
19.....	23.0	36.0	13.0	30	32	31.0
23.....	25.0	38.0	13.0	31	33	32.0
30.....	23.0	37.0	14.0	35	38	36.5
35.....	22.0	32.0	10.0	24	24	24.0
36.....	20.0	37.0	17.0	26	28	27.0

Note—Normal pressure per square inch = 1.5 lb.  
End of groove in cone plugged.  
No circulation of oil.  
3 cc. lubricant used for each test.  
Bearing material = brass.

it is possible to select the most economical oil, it is necessary to know the cost of the lubricant and the cost of power. The most economical oil is not necessarily the most suitable, however, since the factors such as bearing temperature, gumming and cold test must also be considered.

Viewing the problem from an economic standpoint only, and disregarding for the present the other factors mentioned in the preceding paragraph, the general conclusion to be drawn from the above curves is as follows: With the flooded type of bearing (such as used) oil 14 is by far the most durable. Its average power consumption during the long period of operation is, however, greater than the other oils. Oil 19 and oil 30 last for a shorter interval but during that interval the average power consumption is much less. In other words, if cost of power is the deciding factor, then oil 19 and oil 30 are probably more economical to employ than is oil 14, the proportional saving depending on the relative costs of the power and of the oil. Oil 13 and oil 35 appear unsatisfactory in both respects, and unless they possess some other very strikingly redeeming feature not indicated by this test, they cannot be considered in a class with the other test samples.

The investigator may alter his chosen maximum power input and thus slightly modify his numerical conclusion. The object in selecting the maximum load is to duplicate as nearly as possible the allowable frictional load which the local conditions will warrant. As employed above, each type and kind of bearing must be treated in its own individual way, and the investigator must decide on his premise before he may proceed with the test and draw a logical conclusion.

One decided advantage of this form of tests lies in the fact that due to its conical design, even with continued wear, the bearing surface is not altered materially. Practically each individual factor which determines the suitability of a lubricant may be altered at will without disturbing the remaining factors. Thus one can change the speed, pressure of bearing, type of bearing, temperature, or size of bearing each individually or all together. Moreover several types of lubrication may be realized on the same apparatus with but slight change in assembly.

Other oils have also been examined in a similar manner as those above described. Among these were black oils and cylinder oils. The steam jacket was used to advantage in tests on the heavier lubricants.

#### SUMMARY

- (1) An oil tester such as here described proved of value in selecting the lubricant for a specific purpose.
- (2) Curves of experimental results are given from which conclusions are drawn.
- (3) Other methods of testing oils in this same apparatus are outlined.

Research Laboratory,  
Berlin Mills Co.,  
Berlin, N. H.



## Producer Gas and Its Industrial Uses\*

By F. W. Steere

One of the greatest problems now confronting industry is undoubtedly the fuel problem. It is the same old story of prodigal waste until we suddenly find ourselves face to face with a real shortage.

The subject of this discussion is to consider the possibilities of one of the methods of utilizing soft coal, that is, by converting it into producer gas. Producer gas is by no means the panacea for all our ills, but it has its place, and our duty now is to determine to what extent its use can be applied in conserving our natural fuel supplies.

In order to have clearly in mind the distinguishing characteristics of producer gas, we will briefly outline, for the purpose of this discussion, the different kinds of commercial gases most frequently used:

**Natural Gas.**—Made by secret processes of nature, composed largely of methane, usually running about 1100 B.t.u. per cubic foot.

**Oil Gas.**—Made by bringing oil in contact with heated surfaces. The resulting constituents and B.t.u. vary for a given oil through a wide range, depending on the temperature of the heated surfaces.

**Coal Gas.**—Made by the destructive distillation of soft coal in externally heated retorts with the exclusion of air. The resulting coke is withdrawn at intervals, and the retorts recharged with coal. This is the gas most generally made and distributed for domestic use, having a calorific power of approximately 600 B.t.u. per cubic foot.

**Coke Oven Gas.**—A by-product from the manufacture of coke. It runs somewhat lower than coal gas in B.t.u., but in general may be considered as practically the same. Theoretically the process of manufacture is the same as coal gas, the practical difference being in the size and shape of the retorts.

**Water Gas.**—Made by the decomposition of steam coming in contact with incandescent carbon, the resulting gas being largely hydrogen and carbon monoxide. This is an intermittent process, as the carbon must be blown, at frequent intervals, with air to bring it back to incandescence.

**Carburetted Water Gas.**—This is a mixture of water gas and oil gas and is frequently mixed with coal gas and distributed for domestic use.

**Producer Gas.**—As referred to in this paper, it is the product of an incomplete combustion of carbonaceous material—for the purposes of this discussion—soft coal. It differs from ordinary retort gas in that the whole of the combustible part of the fuel is gasified—no residue or coke is left. The heat required for gasification is obtained from the combustion of a portion of the charge of solid fuel which is to be gasified. Producer gas is almost universally enriched by the use of steam blown through the fuel bed with the air—its use being necessary for the practical operation of the gas producer. The volatile constituents of the resulting gas are carbon monoxide and hydrogen, with about 50 per cent of nitrogen. The calorific power of producer gas from soft coal is ordinarily from 140 to 160 B.t.u. per cubic foot.

It is not within the scope of this paper to discuss the chemistry of gas producer reactions, as these are familiar to all of you. We will rather confine our discussion to the problem arising from the commercial application of the gas after leaving the producer, and the types of furnaces in which this gas can be most effectively utilized.

For many years producer gas has been successfully

used in metallurgical work for heating large furnaces, for melting glass, etc. These operations are carried on with hot producer gas, that is, the gas from the producer offtake, which is usually at a temperature of from 1200 to 1400 deg. Fahr., is led directly to the furnaces through brick-lined flues. Producer gas made from soft coal carries large quantities of tar, soot and dust in suspension. It is impossible to keep a large part of this solid matter from being deposited in the flues between the producer and the furnaces. This deposit must be periodically removed by "burning out." The flues are usually so arranged that they may be readily connected to a stack by means of a damper, and, while hot, air is introduced at intervals along the flues, resulting in the combustion of the material deposited. It is obvious that this gas uncleaned, and at a relatively high temperature, could not be conducted for any considerable distance, for instance to a number of small furnaces, without an excessive investment in flues. It would also be very difficult to keep these flues from becoming stopped with the deposits of tar, etc., as the solid matter tends to precipitate much more rapidly as the gas is cooled.

The only practical means for utilizing producer gas in the great variety of heating operations which are found, for instance, in the automobile industry, is to clean the gas completely of all suspended matter and cool it to normal room temperatures. It then can be distributed through any system of piping around a factory, the same as ordinary city gas.

The big problem has always been to make a gas free from both tar and soot. This difficulty of getting clean gas has undoubtedly had more to do with the slow development and adoption of producer gas than all other things combined.

Two general types, or classes, of producers have been developed, the distinguishing characteristics of which are the methods of cleaning the gas:

1. Producers where it is attempted to convert all of the tar to a fixed gas before leaving the producer.
2. Producers which make a tarry gas and rely on outside apparatus for cleaning it.

Suction and pressure producers are found in both of these classes.

The producers of the first-class are built on the theory that if the hydrocarbon vapors, tar oils, etc., which go to make up the very complicated combinations of material that are usually designated as "tar," are brought in intimate contact with highly heated surfaces, these tar constituents will be cracked to fixed gases. The down-draft producers, double-zone producers, and underfeed producers illustrate this class. In these machines the gas is made to pass through the heated portions of the fuel bed, relying on the contact with the incandescent coke to bring about the cracking.

All of the simpler forms of producers, where the fuel is charged at the top and steam and air are blown in at the bottom, come under the second class. The tarry vapors which are distilled from the top of the producers, obviously pass out with the gas and must be cleaned by some external means. This problem of removing tar from gas made in producers of the second class, has been attacked from almost every conceivable angle, such as washing, scrubbing, complicated spray systems, deflectors, centrifugal and whirling machines of almost infinite variety, filtering, pressure and sudden expansion, and precipitation by high-tension electrical discharges.

The high-tension electrical process for detarring gas was invented by the author in 1911. The following extract from a paper\* entitled "An Electrical Process for

\*A paper read on May 17, 1917, before the Society of Detroit Chemists, Local Section, American Chemical Society.

\*METALLURGICAL AND CHEMICAL ENGINEERING, vol. XII, p. 775, 1914.



Detarring Gas," which was read before the American Gas Institute in 1914, describes what takes place in the "ionizer" where the gas is passed through the high-tension electrical discharges:

"An opportunity was provided at the Detroit plant of the Semet-Solvay Company to work out these ideas and develop the theory on which this work is based. This theory, although far from complete, has proven sufficiently accurate to guide us in perfecting a detarring process which is in commercial use to-day.

"In attempting to briefly outline the electrical action, we must keep in mind first that the gas molecules themselves possess both positive and negative electrical constituents which can be separated by X-rays, beta and gamma rays of radium, brush discharge from points, corona discharge from wires raised to high potential, ultra violet light, etc. This process of separating neutral gas molecules into electrically charged parts or ions is called 'ionization.' It is outside the scope of this paper to attempt to discuss the ionic theory, but it should be noted that ions as such are very unstable and cease to exist, that is, recombine to form neutral molecules, almost the instant they are outside the ionizing influence. A very few molecules are continually splitting up, presumably because of the trace of radioactive substances found in most gases as well as in the atmosphere.

"Professor Millikan of the University of Chicago has studied the movements of a small drop of oil between two oppositely charged condenser plates when attacked by atmospheric ions. The drop receives a charge when atomized, so by throwing on and off the electrical field, the drop is made to beat up and down between the plates. The instant an ion attaches itself to the drop the fact is made known to the observer by its change in speed, this change depending on the sign of the ion and the charge on the drop. The important and interesting thing to note is that with over a thousand drops studied in this way, the change of speed was always exactly proportional to the number of ions attached to the drop.

"Let us recall that there are about 27,000,000,000 molecules in 1 c.c. of ordinary air and that each molecule may be separated into at least two ions. When just one of the possible 54,000,000,000 ions per cubic centimeter attached itself to the oil drop it instantly caused an appreciable change in its velocity. Imagine then the violence with which this drop would have been thrown about if all the molecules surrounding it had been ionized.

"This is just the condition we bring about in the electrical detarrer. The gas carrying the minute tar globules is swept into an intense ionizing field. Billions of gas molecules on every side are being torn apart. The resulting ions rush madly about in their effort to recombine. The unsuspecting tar globules find themselves in a storm center of unseen forces hurling them in every direction. The time occupied in the passage of the tar particles through the electric field is brief and it might naturally be supposed, as it heretofore has been, that an aimless to-and-fro movement of them would be the result of the applied energy. It would, however, be hard to conceive of a condition more favorable to impact between tar particles, and experience shows that either because of this impact, or for some reason as yet unknown, agglomeration results and the dense tar mist is almost entirely dissipated, leaving a relatively few large tar drops in its place. This rather figurative description will seem more real to those who have witnessed this remarkable phenomenon within a glass vessel filled with dense fumes or fog. The instant the current is turned on, the whole field can be seen to clarify. The commercial importance of this becomes

more apparent when we realize that this action can be brought about at almost any desired temperature.

"No attempt is made to free the gas of these agglomerated tar particles while it is still in the ionizing field. The apparatus is so arranged that everything is swept on through into some form of mechanical extractor where a complete removal is effected with very little power loss. The Doherty Centrifugal Tar Extractor worked very well to accomplish this; the old type P and A machine also became a very efficient tar extractor when placed after the ionizer.

"The whole process may be summed up in this: It is practically impossible to free the gas from tar in the extremely fine state of subdivision which naturally results from rapid condensation. There is no difficulty in removing relatively large drops and the electrical treatment simply converts the fine mist into the large drops."

Enormous sums of money have been expended in attempting to perfect a commercial process, that is, a process which would deliver clean gas of uniform calorific power continuously. The great difficulty which has always been met, lies in the fact that the success of any gas-making process depends almost entirely, you might say, on the skill with which it is operated. Machines and processes may give perfect results in the hands of the inventors or skilled operators, but when they are sold promiscuously and are handled by unskilled or indifferent operators, the result is failure. This has been the history of the gas producer development for years past, with the result that all clean gas producer development work is looked upon with a great deal of suspicion.

Let us confine our attention to the application of clean, cold producer gas to some of the heating operations which are generally done with other fuels, such as oil, for example. We will first run over, briefly, the types of furnaces which may be adapted to the use of producer gas. These can best be discussed under the following headings:

Double Regenerator.

Single Regenerator.

Double Recuperator.

Single Recuperator.

Combination Regenerator and Recuperator.

Simple furnace where no waste heat is recovered.

For the purposes of this discussion, we will define regeneration as a reversing process, in which the gas or air, or both, to be heated, is first brought in contact with heated surfaces, usually checkerwork, which, in the previous cycle, has been heated by being in contact with the heated products of combustion leaving the furnace. This is the old Siemens process with which you are all familiar.

We will speak of recuperation as the non-reversing process where the products of combustion give up their heat to the incoming gas and air by conduction and radiation through the flue walls. The incoming and outgoing gases are always kept in separate flues.

It is possible to obtain a higher furnace efficiency with producer gas firing and double regeneration than it is possible to obtain with oil. The reason for this possible high efficiency is that the sensible heat of the products of combustion is just about equal to the quantity of heat required to raise the gas and air for combustion to the same temperature as the products of combustion leaving the hearth.

To illustrate—assume a double regenerative furnace working with a hearth temperature of 1650 deg. Fahr. There will be enough heat in the products of combustion to raise the temperature of the incoming gas and air to 1650 deg. Fahr. at the top of the regenerators.

When burning oil, on the other hand, double regen-

eration obviously is impossible. The sensible heat of the products of combustion is greatly in excess of the heat required to raise the air to the temperature of the products of combustion, and very little heat can be taken up by the oil. The balance of the sensible heat from the products of combustion must necessarily be wasted.

Double regeneration with coal gas is not advisable. The hydrocarbon vapors carried in the gas, when brought in contact with the hot checkerwork, are cracked to hydrogen and carbon, the carbon being deposited as soot in the checkerwork. We can see no reason why single regeneration cannot be used with considerable saving, but have no experimental data on this possibility.

Generally speaking, it will not be practicable to build regenerators which would bring about a perfect transfer of heat. In order to demonstrate how far heat recovery could be carried, however, we built an experimental furnace in which the products of combustion leaving the bottom of the regenerators were kept within from 10 to 15 deg. of the temperature of the incoming gas and air. During the test which was run for two days, the products of combustion leaving the furnace were at no time above 85 deg. Fahr. This, of course, was not commercially practicable, as the cost of such a complete saving of the heat was more than the heat was worth. The average stack temperatures of our commercial furnaces are around 175 deg. Fahr., very rarely going over 200 deg. Fahr. We might say that in all of our work, we have found that it is a comparatively simple matter to build apparatus which will save heat, but it is a real achievement to build apparatus that will save heat and money at the same time.

It will be noted that the above discussion applies only to the double regenerative furnace. When firing with producer gas, and using only single regenerators, there must necessarily be a loss of approximately 40 per cent of the sensible heat of the products of combustion leaving the hearth, which are wasted to the stack.

To illustrate the possibilities of producer gas firing, we will describe a set of furnaces which we have designed and built for the Ford Motor Company at Detroit, for heat-treating front axles. Three heat treats are required. After the first heating, the axles are allowed to cool in the air by radiation. After the second heating, they are quenched. After which they are again heated to a lower temperature and allowed to air cool. These furnaces are so designed and laid out that the axles are pushed mechanically through the first furnace and kept moving for a space of about 10 ft., until they reach a temperature within 50 deg. of room temperature. They are then mechanically fed into the second furnace, pushed through and quenched. A conveyor carries them from the quenching tank to the feeding mechanism of the third furnace, where they receive their final heating and are pushed out the rear end ready for the machine operations. It will be noted that the axles are handled mechanically throughout the process, and after being fed into the first furnace, do not stop until the three heat treating operations are complete. These three furnaces have a capacity of completely heating one front axle per minute. Although the heats are different in each furnace, the three furnaces are duplicates, with the exception of the draft and damper settings to bring about the required temperatures. We will describe more in detail one of these units.

The hearth is 5 ft. wide by 14 ft. long. The axles are placed on especially designed cast-iron ways with the forks hanging down. When the furnace is filled with these axles, the axles themselves form a practically solid floor which moves along through the fur-

nace over the ways. Small pieces, such as camshafts, spiders, spindles, etc., are piled on top of the axles and are carried through the furnace, receiving exactly the same heat treatment as the axles. These small parts are handled by hand between each furnace, as no mechanism has, so far, been designed to handle them mechanically. The gas and air are delivered through the reversing valves to the regenerators at a pressure of approximately 3 in. of water. The four regenerators are placed directly under the hearth. The gas on the inside and the air on the outside. There is one combustion chamber immediately over each pair of regenerators and immediately under one-half of the hearth and extending under its entire length. The products of combustion pass through flues along the sides of the hearth, sweep over the hearth, down through the flues on the opposite side, divide after passing through the opposite combustion chamber, and down through the opposite pair of regenerators, through the reversing valves and out the stack. The furnace is reversed on an average of every 15 to 20 minutes. The products of combustion, while passing over the hearth, are directed by a series of jack arches placed every 2 ft. at right angles to the movement of material over the furnace hearth. A solid division wall, built from the foundation to the hearth, separates the two pairs of regenerators. The furnace is enclosed in a steel jacket with 2½ in. of insulating material between steel and brick work.

We might mention that we have built this type of furnace with a muffle to prevent the products of combustion from coming in contact with the steel, the idea of the muffle being to reduce the scaling to a minimum. After several months of comparative tests in running these furnaces with and without the muffle, we concluded that the benefits from the muffle did not warrant the additional expense in construction and operating cost. To maintain an average hearth temperature of 1650 deg., it was found necessary to keep an average temperature in the combustion chamber of 2550 deg. outside the muffle. The average gas consumption was 264 cu. ft. of gas per minute, the average cubic feet of gas per ton of stock being 22,970. The efficiency of the furnace was 14½ per cent.

With the same type of furnace, running under exactly the same temperature conditions and delivering the same amount of stock, without the muffle, that is, the products of combustion coming in contact with the steel, we find that the average gas consumption was 73 cu. ft. of gas per minute, or 11,500 cu. ft. of gas per ton of stock, with a furnace efficiency of 26 per cent, as compared with 14½ per cent, as stated above.

By furnace efficiency, we mean the total amount of heat put into the stock, divided by the total amount of heat delivered to the furnace in the gas.

From the above comparisons, it will be seen that the cost of operating, which will be discussed later, is very much greater when the muffle is used and the practical results on this kind of stock, with skillful operation, are about the same in both cases. We, therefore, conclude that for this type of work the muffle is not warranted. The muffle furnace, we feel, is not at all practicable unless double regeneration is used, as the heat losses would become enormous without efficient waste heat recovery. With double regeneration, however, it will be observed, even with the muffle furnace, a furnace efficiency is possible which is very much in excess of the ordinary oil-fired furnace, which rarely exceeds 10 per cent in efficiency.

We find that the temperature of the stock heated in the furnace can easily be kept within a variation of 10 or 15 deg. By skillful operation, there is no difficulty in keeping the temperature variation within 5



deg. These results have been obtained over tests of several months' duration.

It may be interesting to note that the Ford Motor Company is now adding six additional front axle heat-treating units of the Steere Company design, which will probably be in operation by the first of July.

At the time of writing this paper, we have not completed the work which has been going on for over two years, of developing a furnace to replace oil for drop forging work.

We now have about completed a double regenerative type forge furnace enclosed in a metal case, which will be thoroughly tested out within the next thirty days, but unfortunately, no data are yet available on this particular construction.

It might be interesting, however, to note the data which were taken on a forge furnace which we built and operated for several months on regular production. This furnace was of the recuperative type with metal recuperators. The hearth was 4 ft. wide by 2 ft. deep. The stock heated was 2-in. round bars. Parts weighing 3.88 lb. each were made from the heated bars in an upsetting machine.

One hour and 15 minutes were required to bring the temperature of the furnace from cold up to forging temperature. When the furnace was filled with stock, from 15 to 20 minutes were required to bring the stock to forging temperature. The furnace was run at a capacity of 318 lb. of stock per hour. The temperature of the stock varied from 1850 deg. to 1950 deg. Fahr. The temperature of the hearth varied from 2300 deg. to 2400 deg. Fahr. On an average, a differential of 500 deg. was maintained between the stock and the hearth temperature.

The average of several tests was found to give a fuel cost of \$2.00 per ton of stock heated.

The furnace was operated by putting ten cold bars into the furnace at a time. This naturally lowered the temperature of the furnace, which, as stated above, required from 15 to 20 minutes to bring this stock up to forging temperature. After the stock had been brought up to furnace temperature there was a surplus of heat available and considerable care had to be exercised that the stock was not overheated.

It was found that better work could be done with this furnace than was done with the old furnace, because it was impossible to heat the stock too rapidly, that is, the core and outside of the bar were at practically the same temperature. Also the absence of smoke and dirt made the furnace much more desirable.

The above data were taken on one of the several forge furnaces of different types with which we have been experimenting. We feel that there is absolutely no question that producer gas can be successfully used on all forging operations.

#### ADVANTAGES OF REGENERATION VERSUS RECUPERATION

With properly designed regenerators, it is possible to recover a much higher percentage of the heat of the waste gases than is possible with recuperators, unless recuperators of very elaborate design are built. Recuperators may be built of metal or refractory material. The advantages of metal recuperators are in preventing leakages and short-circuiting. The disadvantages are in their very rapid deterioration, especially at higher temperatures. The disadvantages of regenerators, on the other hand, are that the regenerators must be reversed at intervals of approximately 20 minutes to half an hour, which requires additional mechanism and operating complications. The evidence which we have accumulated to date, however, is distinctly in favor of regeneration and against recuperation, as we have been unable to secure refractories

which have the proper heat conductivity, and at the same time can be kept tight through the wide range of temperatures under which they have to operate.

We find that the expense of a furnace with the stock handled mechanically over the hearth, is not justified unless large quantities of stock of the same kind are to be heated. Also if the heating operations are run continuously for a good many hours, the extra expense of the mechanical furnace is not warranted.

Each particular problem, however, must be studied by itself, as it is impossible to lay down anything more than the most general rules. In a continuous mechanical furnace, such as the front-axle furnace above described, where one axle is charged and one discharged every minute, the front and rear doors must necessarily be open. This, of course, results in quite a loss of heat from the hearth. Intermittent furnaces, built with one door which can be kept closed during the heating operation, show higher fuel economy than furnaces open at both ends.

We have built furnaces similar in principle to the front-axle furnace described above, for use in annealing steel for stamping work where the material was maintained at 1650 deg. Fahr. The costs for this work were practically the same as for the 1650 deg. Fahr. heat treat on front axles, that is 40c. to 45c. per ton. This type of furnace has also been built for carbonizing gears.

We have also applied producer gas with entire success in brazing and for heating enameling ovens.

#### COST OF GAS

The cost of producer gas necessarily varies with the price of coal, water, labor, investment in plant, hours operated daily, etc. The labor and capital charge varies also with the size of the plant. For example, take a plant with a capacity of 3,000,000 cu. ft. of gas per 24 hours, with coal at \$3.00 per ton, producer gas will cost 4¾c. per 1000 cu. ft. A plant with a capacity of 15,000,000 cu. ft. per 24 hours, and coal at \$3.00 per ton, the gas would cost 4¼c. per 1000 cu. ft. On a B.t.u. basis, this corresponds to 4¾c. and 4¼c. oil, respectively. It must be kept distinctly in mind, however, that these figures are costs of the fuel delivered to the furnace and do not take into account capital charges of the distribution systems necessary, capital charges on the furnace investment, repair of furnaces, etc. In other words, it is the total cost of the fuel ready for distribution, rather than the cost of heating stock.

The following data are the result of continuous tests taken on the above described front-axle furnace from April 1 to April 20:

Output of furnace, tons per hour.....	0.781
Cubic feet of gas per hour.....	9,000
Cubic feet of gas per ton of stock.....	11,500
Calorific power of gas B.t.u. per cubic feet.....	127
Cost of fuel per ton of metal (gas at 3½ cents per M).....	\$0.401
Cubic feet of gas per minute for "furnace standing by".....	73
Cost per hour for fuel for "furnace standing by" with gas at 3½ cents per M cubic feet.....	\$0.154
Pounds of stock per hour per square foot of floor space.....	9.1
Per cent of total heat supplied furnace into stock that is, efficiency of furnace.....	26
Per cent of total heat supplied furnace to stack.....	8
Per cent of total heat supplied furnace to radiation.....	66

In the above test the fuel supplied the furnace was measured by means of a station meter. This meter measured the gas supplied to two furnaces, the gas being divided between the two furnaces by means of Pitot tubes installed on both furnaces.

The amount of heat that went into the stock was determined from the rise in temperature of the stock, and its specific heat. This specific heat was determined by laboratory experiment and found to be 0.12.



In the above data, special attention is called to the calorific power of the gas, which is only 127 B.t.u. per cubic foot. The reason for this low B.t.u. is that the gas was made by gasifying pea coke. This also accounts for the low cost of the gas per thousand cubic feet. This gas would be equivalent to ordinary producer gas at 4c. per thousand cubic feet.

This particular test has been selected out of a great many run to show that a very weak gas can be effectively used in a properly designed furnace, which is contrary to the general opinion that a weak gas cannot be effectively used. The results of these tests check very closely with the average of a long series of tests on gases of difficult calorific power.

Independently of ours, tests were run on the same furnace over an extended period, and at the same time tests were run on an oil-fired furnace to determine the comparative fuel costs of the two methods of heating. The results of these tests, which were made independently of our tests, showed that the cost of producer gas per ton of steel was 44½ cents, as against the cost of oil at \$1.48, approximately 3 to 1 in favor of producer gas.

It should be noted again that this cost only applies to the cost of the fuel at the furnace.

We do not pretend to be able to give any costs of heating material with oil. We have run a good many tests and have the results of a great many tests, but there is such a tremendous variation that we prefer to use the figures on oil given us by our clients. We have found that in most cases the tests that were run to determine the costs of heating with oil are run over altogether too short a period. In the work we have done along this line, there have been enormous variations in the quantity used from hour to hour, which leads us to believe that the only way to arrive at a safe estimate is to run the test over a very long period. All of our producer gas data have been taken over a period of at least two weeks, and in most cases are run for two or three months.

In considering the substitution of producer gas for oil, some of the following points should be given most careful consideration. In general, producer gas is not to be considered on small installations. Local conditions and the future price of oil determine when a producer gas plant is or is not advisable. A producer gas plant should be run twenty-four hours a day to realize the best commercial results. It must be also borne in mind that the manufacturing of producer gas is a highly specialized industry in itself, and any concern figuring on adopting this fuel must accept the responsibility of running an entirely separate industry. Also it is difficult to obtain producer gas operators, as there are comparatively few plants running at the present time where men are trained in this kind of work. One of the solutions for this phase of the problem is to build central producer gas plants which will distribute gas to several concerns, having the producer gas plant a separate organization, selling gas to these various concerns the same as the ordinary city gas plant distributes gas.

Plant managers and superintendents must also keep in mind that a radical substitution of fuels must necessarily change their operations to some extent. We have found that it is at first quite difficult to get men who have been accustomed to using oil to change to producer gas, especially if they are working on piece work. After becoming accustomed to gas, however, they prefer it. As has been pointed out above, radical furnace changes are also necessary if the best results from producer gas are to be obtained. In this connection it may be interesting to note that we have in several cases changed over existing oil furnaces to producer gas fur-

naces with entirely satisfactory results as far as heating was concerned. The cost of the gas, however, was necessarily high because of the inefficient use of the gas. The results to date on this kind of work have indicated that the ordinary oil furnace, with a very small expense, can be converted to a producer gas furnace and operated at a cost corresponding to about 6 cents to 7 cents oil.

Briefly, the advantages of producer gas may be summed up as follows:

It furnishes a dependable fuel supply under your own control—that is, it is as dependable as coal.

It can be used for all classes of heating work, including enameling.

The flame temperature being low and the gas volume large, there are no intensely hot spots in the furnace, with the result that repairs on brick work are next to nothing.

The highest furnace efficiencies are possible with gas.

In every application that we have studied we have found that the costs were less with producer gas than with oil.

More uniform heating of the stock, and more accurate control of temperatures were possible.

Last, but not least, every gallon of oil that automobile men use in making cars leaves that much less oil for making gasoline to run them with. Automobile manufacturers, above all manufacturers, should discourage the use of oil for everything outside of making gasoline. The present high price of gasoline, as well as the high price of fuel oil, can be traced back in large part to the tremendous quantities of crude oil that are consumed by manufacturers of automobiles and their accessories.

In conclusion, we call your attention to the fact that practically all of the work which we have done to date has been done while production was in full swing. A great number of practical problems have presented themselves, which it was necessary to overcome in order that production would not cease while the experimental work was in progress.

Also it must be kept in mind that the application of clean producer gas to industrial heating operations may be considered as an infant industry. From our observations to date, however, we feel that the infant is rapidly growing and that the future of this fuel is assured.

**Course in Laboratory Organization.**—A course on Laboratory Organization and Management is offered in connection with the summer session at Columbia University by Prof. Thomas B. Freas and Prof. W. L. Estabrooke. This course is unique in character and content. It is planned to take the students' full time for six weeks. The subjects carried will be: location, laboratory construction, ventilation, etc., of buildings; laboratory equipment, including desks, lockers, shops, gas, electricity, water, suction, liquid and compressed air, balances, etc.; buying from foreign and domestic markets, economic and scientific handling of supplies; organization of stockroom employees and their co-operation with the teaching staff; glass blowing by a professional glass blower will be a special feature; a series of trips in and about New York to manufacturing establishments, industrial and university laboratories, including trips to Boston, Washington, D. C., Niagara Falls, Buffalo, Rochester, Syracuse and Philadelphia, in which there will be opportunity to observe actual application of chemistry to needs of the country from the most modern viewpoint; and especially to the needs of university, college and industrial research laboratories in order to meet the demands of modern chemistry.

## Recent Developments in the By-Product Coking Industry of Japan

By T. Kurahashi

In Japan, especially at Kyushu, Osaka, and Tokyo, there are many coke plants, but most are beehive ovens. There are by-product ovens, however, at the following places:

1. Tokyo Gas Light Company, Ltd., Tokyo.
2. Osaka Seimi Company, Ltd., Osaka.
3. Mitsubishi Makiyama Coke Plant, Tobata, Fukuoka.
4. Imperial Steel Works, Yawata, Fukuoka.
5. Miike Colliery, Omuta, Fukuoka.

Of these the Imperial Steel Works and the Miike Colliery are most important.

The Tokyo Gas Light Company, the oldest and biggest gas company in Japan, has several gas works around the metropolis, namely, Semju, Fukagawa, Oshima, Shiba, Sunamura, Omori, and the Fukagawa tar products works. Of the gas works, the first four are operated with retorts, while the last two, Sunamura and Omori, have by-product ovens. The Sunamura plant has two batteries, one of 18 Koppers regenerative ovens, the other of 15 of the Semet-Solvay type. The Omori plant has one battery composed of 10 Koppers recuperative ovens. Both works recover by-products—tar, ammonium sulphate, and also benzol from the Semet-Solvay ovens. From the Koppers plants, the surplus gas is used for illuminating purposes so that the benzol cannot be recovered, because it is an important illuminating component in the gas. On the other hand, tar and other by-products in the crude state are shipped in small tank boats to the Fukagawa Tar Product Works, and treated so as to produce various dyestuffs, medicines, and other high-grade coal-tar distillation products. The coke is sold for foundries and metallurgical plants, and the breeze for fuel for limekilns.

The Osaka Seimi Company, Ltd., Osaka City, is one of the oldest coke by-product recovery plants in the Japanese Empire, and its former chief engineer, Dr. K. Shimomura, who is the foremost authority on the coke industry in Japan, contracted with the Semet-Solvay Company about twenty years ago, to build one battery of 10 Solvay-type ovens, thus founding the first by-product coke oven plant in Japan.

Now the company has two batteries of the same type, with tar, ammonium, sulphate, naphthalene and benzol recovery plants and dyestuff factory. But last year the dyestuff factory was transferred to the Japanese Dyestuff Manufacturing Company, Ltd., with the similar plant of the Osaka Gas Light Company, Ltd., and hereafter Dr. Shimomura will be the chief engineer of the new company.

The northeastern Kyushu, famous as a coal field and on account of its recent industrial growth, is

important for the coke industry. It contains three by-product coking plants as follows:

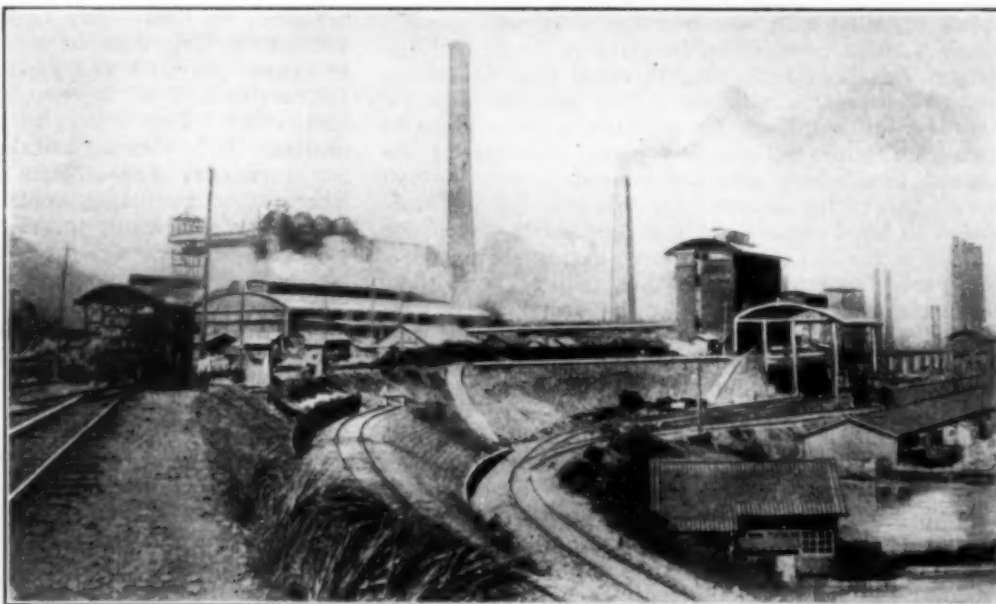
The Mitsubishi Makiyama Coke Mfg. Company was established in 1910, to supply the blast furnace coke to the Imperial Steel Works, and it was originally operated with beehive ovens. But now it has two batteries of Semet-Solvay by-product ovens, one of 25 ovens, the other of 10 ovens, besides 50 beehive ovens. Tar, crude naphthalene, and benzol are recovered.

One of the interesting features of the plant is that ammonia liquor and surplus gas are supplied to the Asahi Glass Mfg. Company, Ltd., the biggest and only window glass factory with the American mechanical blowing system in Japan, and there the surplus gas is used as fuel in the glass making. Ammonia liquor is also furnished to the Am-Solvay Process Soda Manufacturing plant, which belongs to the glass company.

The Imperial Steel Works, the most distinguished steel and iron works in the Orient, have coke plants for the blast furnaces. They were formerly beehive ovens of the Coppee type, but are now by-product ovens of the Semet-Solvay and Koppers types. The Semet-Solvay plant comprising 150 ovens, arranged in six batteries of 25 each, each oven having a capacity of 6 to 7 tons of coal, had been built up in 1907-8; on the other hand, the Koppers type, comprising one battery of 120 ovens, each of 7 tons capacity, were begun in 1914. Tar, ammonium sulphate, naphthalene, and benzol recovery plants are in operation, and the benzol is supplied to the Japanese Dyestuff Manufacturing Company.

In this connection, I will mention the results obtained in experiments on the utilization of coke-oven waste heat for steam raising with the Babcock & Wilcox multitubular boilers by the engineers of the Steel Works. The waste heat from one battery of the Semet-Solvay ovens which carbonize 100 tons of coal per day, can raise 45.6 tons of 8 atmospheric pressure steam per day, that is, 456 kg. per ton of coal per day; on the other hand, the surplus gas from the ovens can raise 580.8 kg. of steam per ton of coal carbonized, thus we have a total of 1036.8 tons of steam per battery per day. The steam, of course, is used for steam engines in the central power station of the works.

It is said that the Steel Works had decided to contract for any new type of coke oven of recent enlargement, and it will apparently contract with some American by-product coke oven builder as yet undecided.



WHOLE VIEW OF COKE PLANT, IMPERIAL STEEL WORKS, YAWATA, FUKUOKA



The Miike Colliery, the largest colliery in Japan, which belongs to the Mitsui Mining Company, Ltd., Tokyo, has the most improved 122 Koppers regenerative ovens in four batteries (in which is No. 4 battery just put in operation), each oven of 8 tons capacity; the coal carbonized amounts to about 120 tons per battery per day. Plants for the recovery of tar, ammonium sulphate (Koppers direct process), naphthalene, anthracene, and benzol, and also for the manufacture of dyestuffs are provided. Of these, alizarine dyestuffs produced from the anthracene are the only ones successfully made in Japan. The gas produced amounted in 1916 to 3,600,000 cu. ft. per day (from three batteries) of which 1,800,000 cu. ft. were used for the coking, 1,200,000 cu. ft. for the two gas engines, each of 3,000 hp. (one is spare), the surplus for boilers, zinc furnaces, etc., and finally a part for delivery to the city for the use of the Omuta Gas Light Company, Ltd.

According to news which I received a few days ago from Tokyo, it would seem to be a fact that the works are engaged in research on a type of new coke plant that will be built in parallel with the present Koppers ovens, and that the works will select some new type, now being improved in the United States of America.

The South Manchurian Railway Company, Ltd., has decided to adopt the Roberts type of oven for the coke plant which will belong to the An Shan Chan Steel Works in South Manchuria, and the company has contracted with the American Coal and By-product Coke Company of Chicago, Ill., about the new coke and its by-product plants. The annual output of coke is said to be about 150,000 net tons.

The coal used in present practice in the works mentioned above is as follows:

	Ash	Vol. Mat.	Fixed Carbon	Sulphur	Locality
Bujun .....	7.53	50.36	42.11	0.71	Manchuria
Miike .....	14.85	40.23	44.92	2.92	Kyushu
Takashima .....	8.58	37.15	57.27	0.95	Kyushu
Honkeiko .....	20.54	21.52	57.94	0.143	Manchuria
Kaihei .....	14.70	31.70	53.60	1.183	Manchuria
Amakusa .....	10.92	17.20	71.88	0.976	Kyushu

Among them, "Takashima" produces good coke, low in ash and sulphur, high in calorific power and moderate in coking power, but a little high in phosphorus.

"Miike" is famous too, of high calorific power, moderate caking power, rich in by-products, but one defect is its high sulphur content.

"Honkeiko," low in sulphur, phosphorus, and volatile materials, produces good coke, but it is unsuitable for use in the blast furnace because of its high percentage of ash and also its high melting point. "Kaihei," "Sakito," "Futase," "Amakusa," are good too.

With respect to the by-product coke industry, there is a great question as to the future of the dyestuff manufacture in Japan. The importations of dyestuffs into Japan, almost all of them from Germany, were as follows (1 yen = \$0.50):

	Synthetic Indigo	Other Coal-tar Dyes
1913.....	Yen 1,879,967	4,154,658
1914.....	3,277,362	4,485,691
1915.....	.....	.....
1916.....	123	2,385,526

This shows that the annual importations amounted to about 7 or 8 million yens, that is nearly 3.5 or 4 million dollars. But since the beginning of the great war, importations have been cut off, and the shortage of the stock has brought about an unnatural rise in their prices. Under these circumstances, many consumers have turned their attention to the possibilities of home supply.

Japan has 40 color works now, but many of them being on a very small scale are unsuitable for that kind of industry. The few which follow are the exception:

1. Tokyo Gas Light Company, Ltd., Tokyo.
2. Japanese Dyestuff Manufacturing Company, Ltd., Osaka.
3. Yura Dyestuff Manufacturing Company, Ltd., Wakayama.
4. Miike Colliery Omuta, Fukuoka.

In my opinion, it would be better for Japan to have one or two large works (say one in Osaka and the other in Kyushu) instead of forty or more little works. When peace comes, I am afraid that the small works will suffer and many of them be forced to stop operation, but the excited Japanese manufacturers will not heed my advice, and I fear that time will prove the correctness of my opinion.\*

\*The author of this article is at present in this country and will be glad to answer inquiries concerning the above subject or other chemical and metallurgical industries in Japan. His address is care of Japanese Consul General, New York City.

### Potash from Cement at the Riverside Portland Cement Company

In our June 1 issue, page 653, we gave a short description of the work being carried on in the recovery of potash at the plant of the Riverside Portland Cement Company, Riverside, Cal. We are indebted to Mr. John Treanor, manager of the company for the following additional data.

#### GENERAL CONSIDERATIONS

This company is now recovering 6 lb. of potassium sulphate for every barrel of clinker burned. This quantity at present price is worth from 40 to 50 cents per barrel of cement produced. On the pre-war basis the same material would have a value of about 18 cents



FIG. 1—HOT WATER AND MIXING TANKS AND BELT DISPOSING OF FILTER CAKE



per barrel, a figure which would still leave a very attractive net profit.

Clays and shale suitable for Portland cement manufacture vary in  $K_2O$  content up to values as high as 2½ per cent. During the past year many Portland cement raw mixtures from Eastern manufacturers which were examined in the Riverside laboratories were found to contain from 0.8 to 1.25 per cent of  $K_2O$ .

In the ordinary burning of Portland cement raw mix, from 40 to 50 per cent of the potash content is volatilized and leaves the kiln with the kiln dust. This volatilized potash can be recovered in the form of a more or less dilute salt by the installation of suitable dust collecting systems.

The amount of potash recovered depends upon the efficiency of the collecting devices. The efficiency of the Cottrell electrical precipitators varies from kiln to kiln; the best individual kilns giving results as high as 80 per cent of the potash volatilized, while individual treaters over other kilns have an efficiency as low as 55 per cent. A 100-ft. rotary kiln, for example, may produce anywhere from 4 to 7 tons of dust daily, whose average potash content may range between 4 and 10 per cent. The Western Precipitation Company worked out the problems of electrostatic precipitation.

The potash contained in this dust is usually water soluble, or if part is insoluble it will be amenable to further chemical treatment. This potash containing dust recovered from the kiln gases can be sold as dilute fertilizer just as it is. Such a by-product is regularly being produced by the Security Portland Cement Company at Hagerstown, Md., and by the Alpha Portland Cement Company at its plant on the Hudson River.

The use of this dust, however, is restricted to agricultural operations requiring a lime base fertilizer. It cannot be conveniently used as an ingredient for a complete fertilizer on account of its dilute form. The cost of freight upon 90 per cent of inert material is burdensome, reduces the net selling price, and limits the available market. The usual requirement for complete fertilization work is a salt whose  $K_2O$  content is not under 35 per cent, and it is toward this ideal that efforts have been directed in striving for a process for recovering potash from cement plants.

The potash recoverable from all cement kilns under all conditions will be in the form of potassium sulphate. During the past five years the laboratories at Riverside have been working on the problem of deriving a more concentrated salt from this dust. One of the obstacles, however, was that only 50 to 55 per cent of the total  $K_2O$  originally present in the dust could be extracted in water soluble form.

Recently it has been discovered that the cause of this

poor extraction was the formation of a double salt of potassium and calcium sulphate which at ordinary temperatures has a low degree of solubility. This double salt is the mineral syngenite, occurring in nature. Knowing the cause of the poor extraction it was but a step further to remedy it, and it was finally found that by keeping the mixture at a minimum temperature of 85 deg. C. during the leaching and filtering process, and maintaining proper conditions of concentration, all of the water soluble potash originally present in the dust could be recovered. A patent (No. 1,220,989) based upon this simple fact has been obtained.

#### CALCIUM FLUORIDE PROCESS

For every 1 per cent of  $K_2O$  in the raw mixture it would be theoretically possible with this process to recover 6 lb. of  $K_2O$  from each barrel of clinker, providing the volatilization is complete. Upon the pre-war basis of 3 cents per pound, this would amount to 18 cents per barrel, so that any economical means by which a better volatilization of  $K_2O$  from the clinker could be accomplished would be decidedly worth while. Working toward this end a process was developed (patent No. 1,194,344) which makes use of calcium fluoride as a reagent for increasing the volatilization of potassium salts from the clinker and the regeneration of the reagent from the dust collected. This is accomplished as follows:

For every 1 per cent of  $K_2O$  present in the raw mix, approximately 0.8 per cent of calcium fluoride is added. This addition permits the formation of potassium fluoride, which is readily volatile and has a boiling point of about 850 deg. C. The reaction between the calcium fluoride and the potash in the raw mix, however, does not take place until a temperature of about 1100 deg. C. is reached. At this temperature, which is far in excess of its boiling point, the salt will be rapidly expelled from the raw mixture and carried off with the gases of combustion and the dust.

This volatilized potassium fluoride, however, does not persist in this form. It is more or less completely converted by the oxides of sulphur in the gases of combustion to potassium sulphate. This transformation is accompanied by the liberation of hydrofluoric acid, which is immediately neutralized by the lime compounds in the dust and is converted into calcium fluoride. This dust is then leached by the process already described and the soluble potassium sulphate separated from the insoluble calcareous and argillaceous material by filtration.

The filter cake obtained by this operation is a useful raw mix containing in addition to cement making substances all of the calcium fluoride originally used, and



FIG. 2—EVAPORATING PONDS, AND POTASH PLANT

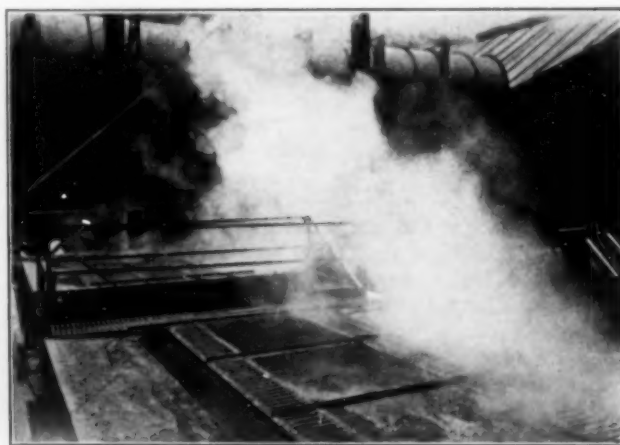


FIG. 3—EVAPORATING PANS, "COOKERS"

in addition to this the deleterious constituent, lime sulphate.

Originally it was attempted to enrich the dust by reburning it, and although this gave a very rich potash dust, the operation was extremely uneconomical. In fact, only 20 per cent of the total potash fed into the kiln in the shape of stack dust and treater dust was volatilized. The remainder, or 80 per cent, was driven into the clinker.

The cause of this was found to be the calcium sulphate present in the dust. In the presence of fluoride, however, the calcium sulphate decomposes, which discovery was embodied in patent No. 1,219,315. This reaction then makes it possible to again return the filter cake containing among other things the calcium fluoride to the raw mix where the calcium fluoride again performs its function of increasing the volatilization of the potash in the raw mix. By this cyclic process the volatilization at the Riverside plant was increased from 60 to 90 per cent.

Summing up the possibilities of recovery of potash as a by-product in Portland cement manufacture, the experience at the Riverside plant indicates that 90 per cent of the potash contained in the raw mix can be volatilized; 10 per cent remaining in the clinker. Eighty per cent of the potash so volatilized in the kiln should be caught by the dust collectors. The net product, about 70 per cent of the original input, will be still further reduced about 5 per cent by losses in filtering. It has been demonstrated by the work at Riverside that it is entirely conservative to look for the recovery, in the form of concentrated salt, of 66  $\frac{2}{3}$  per cent of the potash originally contained in the raw cement mix, and it is quite possible that even these results may be

improved upon by increase in the efficiency of the dust collectors. The resultant salt is received most enthusiastically by the fertilizer trade.

#### MECHANICAL FEATURES OF THE PROCESS

The dust is drawn from bins under the electrical treaters into tanks where it is put into solution by agitation in water of not less than 85 deg. C. at a concentration of not over 5 per cent  $K_2O$ . The apparatus consists merely of cylindrical tanks some 12 ft. in diameter and 8 ft. high, which have on their axis a vertical shaft carrying ordinary propellers. The tanks are filled with water to a depth of about 6 ft. and the water brought up to the desired temperature by means of steam injected into it. Fig. 1 shows two hot-water storage tanks on the left and one of the agitator or mixing tanks on the right. There are three of these mixing tanks, each delivering a batch every fifty minutes. The dust is then charged into this heated water and the temperature rapidly rises to boiling point, due to the hydration of the lime contained in the dust. Samples are taken every few minutes, filtered, and specific gravity determined as well as percentage of solids. The potash goes into solution surprisingly fast under the conditions described. The whole operation of extracting the water soluble potash from 7 tons of dust is accomplished in less than fifty minutes, and the whole control has reduced itself to a very simple basis.

As soon as a batch is cooked in one of the tanks it is run by gravity into the filter reservoir under an Oliver filter press, where its temperature is maintained by steam coils, and the whole is kept at a homogeneous consistency by means of an agitator. The suction of the filter drum then forms a cake, and as the drum revolves this cake emerges from the pulp and encounters a bank of hot water sprays. Suction is applied automatically after passing this point to remove as much water as possible from the cake, which, when it reaches the horizontal position of the floor level, is scraped off by means of a plow.

The solution thus extracted from the cake is passed directly to storage tanks (Fig. 2), which are at the same time settling and evaporating ponds by means of solar evaporation, which is very active in the dry climate of southern California. When the liquid has attained a specific gravity of about 1.1 per cent it is pumped to the evaporating pans (Fig. 3), where the liquid level is maintained at a fixed point and the solution becomes more and more concentrated and the salt drops to the bottom. The company has five of these pans installed. It is then raked out upon a drain board, where it is allowed to remain some minutes, and thence is deposited in a hopper, where draining continues for several hours (Fig. 4). From this hopper it is passed through a rotary dryer, thence through a William's mill, where it is reduced to the desired fineness, and finally the salt proceeds to a bin under the sacking machine.

Credit for the invention of the chemical processes employed belongs to Frederick W. Huber, chief chemist of the Riverside plant, and to his assistant, Frank F. Reath.



FIG. 4—BINS WHERE WET SALT IS STORED TO DRAIN, ALSO ROTARY DRYER FEED

**Manufacture of Calcium Carbide in Brazil.**—According to the annual report of the Companhia Brasileira Carbureto de Calcio, established in the city of Palmyra, State of Minas Geraes, the production of calcium carbide by this company during the year 1916 was 61,016 drums, as against 50,146 for the previous year. The board of managers calls attention to the fact that not only is the product well received in Brazil, but that considerable quantities have also been exported to the Argentine Republic.



## Synopsis of Recent Metallurgical and Chemical Literature

**Switchboard for Experimental Work.**—A description of a cheaply constructed laboratory switchboard, especially arranged to give great current flexibility, was given in a paper by W. L. BADGER at the recent Detroit meeting of the American Electrochemical Society. The board was built in the shops at the University of Michigan in 1915 and is used by the Chemical Engineering Department. It is stated to have cost a little over three hundred dollars. The transformer is rated at 10 kva. and is built for 230 volts on the high-tension side. The high-tension winding has five taps, so that low-tension voltages of 10 per cent above nominal, 5 per cent above nominal, nominal, 5 per cent below and 10 per cent below, may be obtained. On the low-tension side are two 10-volt coils and two 20-volt coils. The transformer was obtained from the Enterprise Electric Co., Warren, Ohio. A diagrammatic sketch of the wiring is shown in Fig. 1. The supply line is connected to a double-pole circuit breaker shown at the top of the board. This is provided with both overload and shunt release coils. From the breaker the current passes to the double-pole double-throw switch *I*, which connects the 220 volts either to the busbars direct, or to the high-tension side of the transformer through the three single-pole double-throw switches *E*, *F* and *G*. The five taps of the high-tension winding are connected to these as shown by the numerals. By suitable combinations of series, parallel or series-parallel connections, low-tension voltages, can be obtained of 60, 50, 40, 30, 20 or 10 volts at ratings of 100, 83, 67, 100, 100 and 33 per cent respectively. With any one of these arrangements the

voltage may be varied through five smaller steps by means of the switches *E*, *F*, and *G*, as shown above. The result is a very flexible arrangement, particularly suitable for granular carbon resistance furnaces where there is a wide range of resistance, as temperature changes. From the low-tension connections the current passes through the ammeter transformer and then to the furnace-room busbars.

**Potash from Feldspar.**—In the Canadian Chemical Journal, Vol. 1, No. 1, May, 1917, D. J. BENHAM, secretary of the National Potash Corporation of Toronto, describes a process used by this company in extracting potash from feldspar. The process was worked out by Allan Grauel of Kitchener, Ont., who was financially interested in a powder plant at the beginning of the war. The impossibility of securing the necessary potash for their operations induced him to devote his attention to the problem. The process, which is protected, consists in heating to a high temperature in a blast furnace, 110 tons of a mixture of feldspar, coal, calcium chloride and limestone. The limestone is used to render the slag fluid, while the chlorine of the calcium chloride combines with the potash, forming potassium chloride which distills over at the temperature of the blast furnace into a condenser where it meets a current of steam, in which it dissolves. By a process of evaporation and crystallization of the solution thus obtained, the salt is obtained in a high state of purity. It has been exhaustively tested out in the plant of the National Portland Cement Company, Ltd., at Durham, Ont. The success of the process is stated by the author to be in a large measure due to the earnest co-operation and assistance rendered by Mr. William Calder, formerly president and general manager of the plant at Durham, who unsparingly placed his extensive, modern equipment as well as his personal resources at the disposal of Mr. Grauel for the concluding experiments under commercial conditions.

It was found possible, with proper preparation of the charge, to drive off, under the most favorable conditions, over 90 per cent of the total potash content in the feldspar, which ranges from 8 to 14 per cent K<sub>2</sub>O. The present percentage of collection of the vapors is not entirely satisfactory, however, and improvements are under way on this feature of the process. A satisfactory process for disposition of the soda vapors from the potash has also been developed. The mother liquor containing the potassium salts after being drawn off from the gas condensing and filtrating equipment is subjected to centrifugal treatment and evaporation. An evaporating pan, 12 x 60 ft. by 1 ft. deep being utilized. The gas treating equipment consists of a coil through which the volatilization products are collected and precipitated with steam. For the present only muriate of potash will be produced but satisfactory experiments have been conducted in the manufacture of caustic potash. It is of course also comparatively easy to produce chlorate from the chloride, but the entire manufacturing attention of the National Potash Corporation, Ltd., the company which has been organized to operate under Mr. Grauel's patents, will be concentrated on the production of muriate, which is so urgently required in the manufacture of explosives and for fertilizers for the great wheat, corn and cotton belts. Within a short time, however, the equipment for manufacturing caustic will be installed. The company expects to have its first unit with a capacity of 20 tons a day in active operation by the first of June.

It is stated to be possible to so adapt the process and the equipment as to utilize cement marl as a raw material instead of feldspar, where the latter is not readily obtainable, and it is also possible to utilize either rotary kilns or blast furnaces of a certain type for releasing

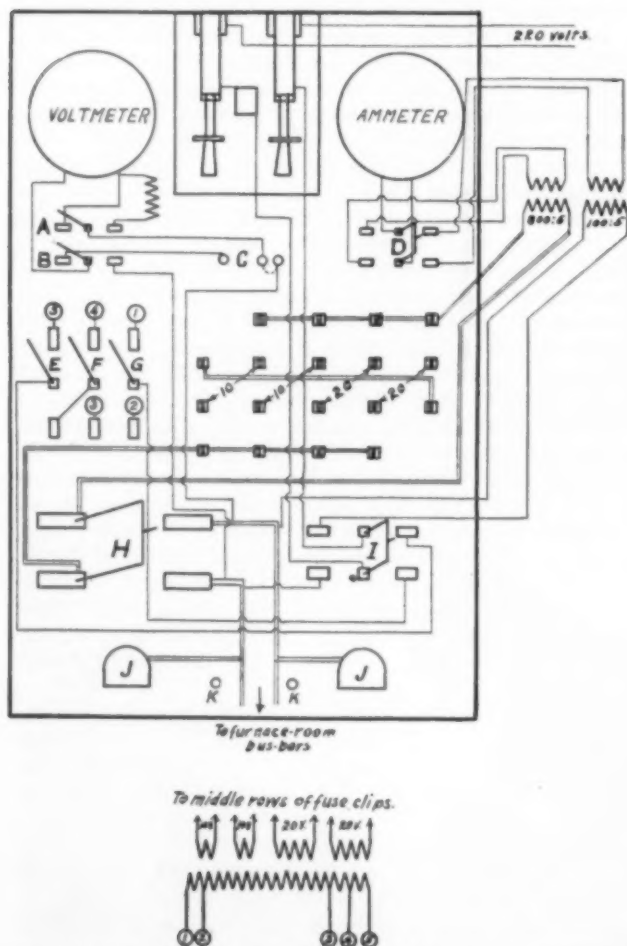


FIG. 1—TRANSFORMER BOARD FOR ELECTRIC FURNACES



the potassium fumes. In operating the blast furnace the slag is converted into sewer pipe, tile and paving brick, being poured direct from the furnace into the molds. It has a peculiar porcelain-like surface like all feldspar products. An interesting statement made in the article is as follows: "By their aid (the feldspar fields), the Canadian company will assuredly be able not only to break effectively the world-wide monopoly of Germany in potash production, but it should be able to capture and hold securely the whole American market if it treats the consumer fairly." There is, however, a peculiar feature connected with the burning of feldspar, for which no reason is yet revealed. This is the fact that all of the potash content does not volatilize at the same degree of temperature. A certain percentage is released at say 900 deg. C., more at 1000 deg, and so on until the last of it is finally driven off at about 1600 deg. This feature has presented grave difficulties.

**Ferromanganese.**—In the Journal of the Franklin Institute for May, 1917, ROBERT J. ANDERSON gives a review of the ferromanganese situation since the outbreak of the war. He points out that prior to the war we were the only steel producing country which did not produce its requirements of ferromanganese. Our steel manufacturers were obtaining cheap supplies from England and Germany and prior to 1914 the only company in this country manufacturing ferromanganese was the United States Steel Corporation. Since the war started, however, the manufacture of ferromanganese and spiegeleisen has been actively taken up and in 1916 we not only produced 75 per cent of our requirements, but both ferromanganese and spiegeleisen were exported to Canada, Italy, Sweden, Holland, Australia, etc. Most of the manganese ore for this production came from Brazil. Russia and India were formerly large exporters to other countries but these sources of supply were cut off and we have had to depend on Brazil for our manganese ore for making ferromanganese. Prices for ferromanganese in 1916 reached unheard of levels and the development of substitutes would be most acceptable to the steel producers. The author sums up his article as follows:

"It appears, in the light of the facts presented in the foregoing, that the manganese situation is one of serious importance—one that warrants thoughtful consideration on the part of those interested in the subject. The possibility of metallurgical science discovering a substitute deoxidizer which will take the place of manganese, either in whole or in part, appears to be an alluring one. Naturally any attempt at such an endeavor will call for a large amount of labor on the part of many men, and it is not to be supposed that the final solution of the problem will be effected in any short time. The matter of obtaining suitable co-operation with steel makers for the use of their plants so that experiments may be carried out on a scale commensurate with that of practice is one that will have to be taken care of by research men who hope to contribute in large measure to any progress along this line. Steel works laboratories have an opportunity before them if they have not already grasped it—and they apparently have not, if published data can be any criterion. A recent investigation carried out in this country by H. M. Boylston [Carnegie Scholarship Memoirs of the Iron and Steel Inst., Vol. 7, p. 102 (1916)], appears to be the first well-defined attempt in this direction."

**Pyrometers.**—Before a recent meeting of the Steel Treating Research Club of Detroit, Mich., RICHARD P. BROWN, president of the Brown Instrument Co., of Philadelphia, Pa., presented a paper on "Pyrometers—Past, Present and Future." Mr. Brown gave a history of the development of temperature measuring devices, and pointed out along what lines development in the

future may be looked for. He discussed air, gas, water, optical, radiation, resistance and thermo-electric pyrometers. The thermo-electric method is the one in greatest use and he took up a discussion of the millivoltmeter and potentiometer methods of thermo-electric pyrometry. He said "the advantage of the potentiometer method of measuring temperature, is in its extreme precision, and its independence of resistance changes throughout the thermo-couple circuit. It has the disadvantage as compared with the millivoltmeter method that it is not direct reading, and that some outside source of current, a dry cell, for example, is necessary as a source of current to oppose the thermo-couple, and this cell must be replaced frequently."

In discussing the future for pyrometry, he said "it would seem that the greatest development work in temperature measuring instruments will be done with the perfection of optical pyrometers, resistance thermometers and thermo-electric pyrometers. There is a field for a high grade optical pyrometer which can be used by any number of operators, who will all secure the same results from the instrument. Resistance thermometry will for some time continue to be limited to use at low temperatures unless some suitable metal is found for use in place of nickel to form the bulbs. In thermo-electric pyrometry it is possible to develop better materials than those found to date for base metal thermo-couples. The insulation or protecting tube will be difficult to improve upon. With the direct reading millivoltmeter doubtless the resistance of these instruments will be greatly increased, and I know that we have spent an endless amount of development work the last year or two along this line, and other pyrometer manufacturers are doubtless doing the same thing. The more the internal resistance of the pyrometer can be increased, and at the same time maintain the robustness of the construction, the better the instrument. With the potentiometer method of temperature measurement, doubtless development work can be carried on to advantage in producing an indicating instrument which will be direct reading throughout the scale range, and which will be simplified and less delicate than the types available at the present time. I think, however, the greatest future in pyrometry is along the line of automatic temperature control. I have with me here an instrument which automatically controls the temperature of an electric furnace. By means of solenoid operated switches the circuit is opened and closed through the rheostat, maintaining the temperature constant within 10 deg. Fahr. We have one of these automatic temperature control instruments in use on a japanning oven at the Willys-Overland Co., in Toledo, and nineteen more under manufacture for them. These instruments automatically maintain the temperature constant in an electrically heated oven, and this same type of instrument can just as easily be used on electric heat treating furnaces. We are experimenting with an instrument at present on an American Gas Furnace to operate gas valves, and control the temperature automatically, and while this instrument is in satisfactory operation in our own plant, it is not developed to a point where it is ready for general use. In closing, I wish to also suggest that the various steel manufacturers, and men like yourselves, who are interested in the improvement of heat treating methods, can be of great assistance to pyrometer manufacturers in co-operating with them to test out new devices in an endeavor to improve on present methods. We have made great strides in this country in the past few years in improved methods of heat treatment, and co-operation on the part of all concerned will mean very much greater strides in the next few years."

## Recent Metallurgical and Chemical Patents

### Sintering

**Sintering Fine Ores.**—A continuous sintering machine, especially designed for sintering iron oxide ores is patented by HEINRICH BITTMANN, of Frankfort-on-the-Main, Germany. The patent is assigned to the Dwight & Lloyd Sintering Company, of New York City. A longitudinal section of the apparatus is shown in Fig. 1 and a cross-section in Fig. 2. A layer of fuel is fed

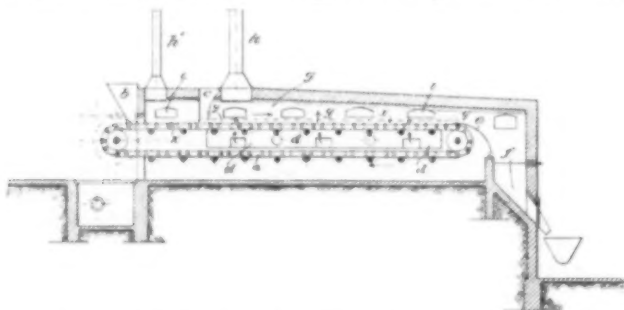


FIG. 1—LONGITUDINAL SECTION OF SINTERING MACHINE

onto the revolving grate *a*, from hopper *b*, and onto the fuel layer is fed a thin layer of ore, or ore mixed with fuel, from hopper *c*. The fuel is brought to ignition between the feed hoppers *b* and *c* by pressure or suction blast. An air box *d* is arranged below the charge support and air is supplied to this box, and passes upward through the grate, fuel and ore. The sintered material is delivered from the grate at the end

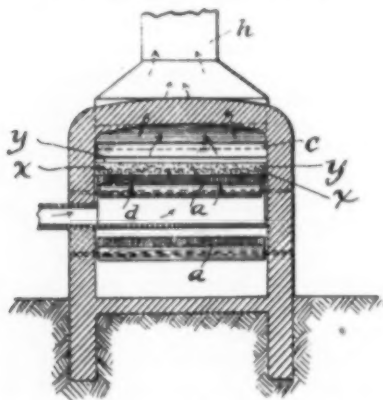


FIG. 2—CROSS-SECTION OF SINTERING MACHINE

*e*. For conducting away the gases the grate base may be surrounded by a flue space *g*, from which flues *h* and *h'* extend, and the flue may be provided with man-holes *i*. (1,221,962, April 10, 1917.)

### Mercury

**Roasting Furnace with Fume Condenser.**—An ore roasting furnace with condenser which is designed to operate on ores containing volatile metals such as quicksilver and zinc is patented by WILLIAM W. WHITTON, of Oakland, Cal. A cross section of the apparatus is shown in Fig. 3, in which *A* indicates in general a furnace constructed of brick and suitably lined to resist high temperatures; 2 the fire-box and 3 a main heating chamber which is provided with retort tubes generally indicated at *B*. Extending across the main chamber 3 are superposed frames 4, which are provided for the purpose of uniformly distributing the heat from the fire-box about the retort tubes before escaping through the flue indicated at 5, which may be connected with a stack not here shown. Each frame 4 consists of an iron grating, provided with staggered rec-

tangular shaped openings. These openings are provided for the purpose of permitting the insertion of the individual retort tubes and also to permit the same to be readily removed. The furnace gases travel in the direction indicated by the arrows. Extending through each retort tube is a perforated pipe 17. Mounted below the bottom frame 20 is a plate 21 and mounted below said plate is an inclosed tank 22, which is partly filled with water. The lower ends of the individual perforated pipes 17 are connected with the upper end of this tank and the tank is in turn connected through a pipe 23 with a suitable form of condenser 50 and a suction blower 51. Mounted on top of the furnace *A* is an ore-bin 24, the bottom of which is formed by the frame 12 and the open ended retort tubes *B*. The ore delivered to the bin 24 is permitted to fill the individual retort tubes and the ore thus delivered to the individual tubes is prevented from freely discharging through the lower ends by the plate 21. The mercury or other volatile products from the ore are drawn off through

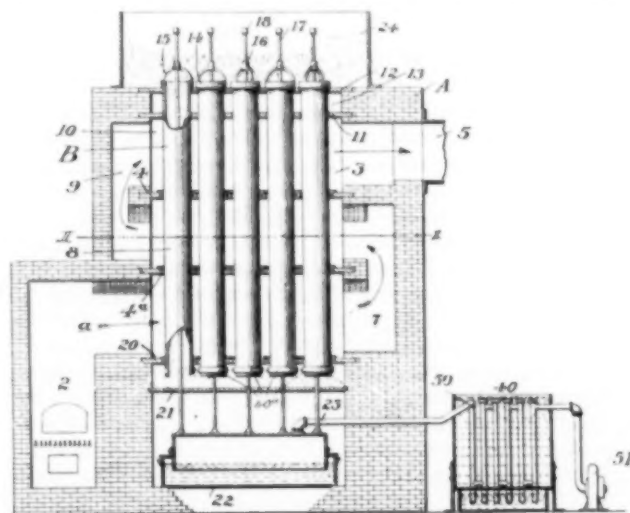


FIG. 3—SECTION OF MERCURY FURNACE

pipe 17 by suction from the condenser and blower. The liberated volatile products are thus drawn directly into the tank 22, where they strike the surface of the water contained therein. A comparatively large proportion of the products are here condensed and permitted to settle in the form of a pure metal while the remaining products are drawn through the pipe 23 where they are finally precipitated in the condenser. With a furnace constructed as described, the products of combustion are not brought into direct contact with the ore nor is the ore raised to a temperature which will liberate the injurious corrosive gases such as sulfurous or sulfuric acid. (1,222,251, April 10, 1917.)

### Calcium Carbide

**Calcium Carbide and By-product Recovery Furnace.**—An electric furnace, adapted to produce calcium carbide and coal tar products is patented by J. H. REID of Newark, N. J., and assigned to the Patents Process Company, a Maine corporation. A cross-section of the furnace and condenser is shown in Fig. 4. The furnace proper is simple in construction. From the cover, extends the outlet 18 provided with the fluid seal 19 and the revolving damper 20. The upper section or cover 9 is also provided with a sealed feed inlet 21 the seal of which may be removed and replaced while supplying ingredients to the apparatus during the performance of the process and closed during the condensing operation. The outlet 18 with its fluid seal 19 communicates with a removable conduit 25 operating



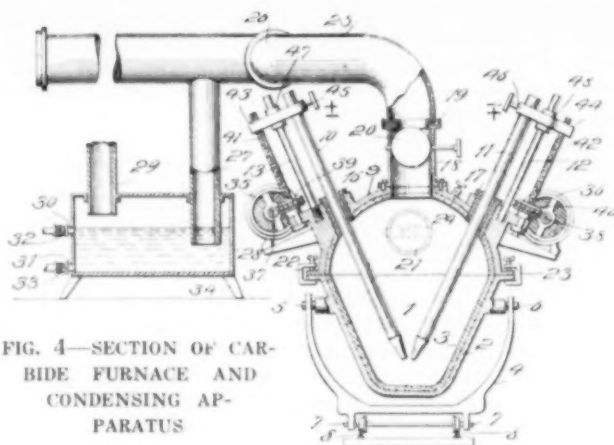


FIG. 4—SECTION OF CARBIDE FURNACE AND CONDENSING APPARATUS

through the swinging joint 26. This conduit communicates with an outlet 27 leading to the reservoir 28 and through which the condensed volatile products pass to the same, the reservoir 28 being provided with an outlet 29 for the permanent gases and whereby the said gases are conveyed to a reservoir (not shown). The apparatus is stated to be applicable to the production of calcium carbide from bituminous shale and lime, with the recovery of tar or volatile products such as benzol, toluol, etc., evolved during the action of the electricity on the charge. (1,224,788, May 1, 1917.)

#### Welding

##### Welding Compound for Nickel and Nickel Alloys.—

A flux for use in the autogenous welding of nickel and nickel alloys is patented by RICHARD SAMESREUTHER, of Dusseldorf, Germany. The object of using the flux is to overcome the absorption of oxygen and other gases and embrittling of the welded piece on cooling. Porosity is also claimed to be overcome. The essence of the invention is that in order to effect a proper welding of nickel or nickel alloys, there must be present (in addition to metal of the same character as the one to be welded) three substances or ingredients, viz. first, alkali, second metal chloride, and third, chromium. The purpose of the alkali is, stated above, to form a fireproof film during welding. This film, however, would prevent the parts to be welded from fusing together, and to avoid this detrimental action, metal chlorid and chromium are used during the welding process. Waterglass may be used as the alkali and chlorides of magnesium or molybdenum as the metal chlorides. Chloride of calcium may also be added to dissolve any possible slags. (1,224,418, May 1, 1917.)

#### Light Alloys

**Aluminium-Calcium Alloys.**—Aluminium-calcium alloys and the process of manufacture are patented by HUGH S. COOPER, of Cleveland, Ohio, (assigned to the Cooper Company, of Cleveland, Ohio). An alloy of 8 to 10 per cent calcium and the balance aluminium which is the favored composition is much lighter than aluminium alone, is stated to be much harder, more resistant to corrosion and to machine easily. The calcium also acts as a deoxidizer. The process of manufacture is described in the specification as follows:

In view of the fact that calcium burns, even when heated to a low temperature, the alloy cannot be made by simple fusion of the mixed metals. Consequently, the steps practised by me in making these alloys is to melt the aluminium first and heat to about 800 C. The melted product is then removed from the fire and calcium in the form of small pieces pushed under the surface of the melted aluminium and held there until melted. Upon the introduction of each piece of calcium a slight reaction takes place with a rise in

temperature of the melt, and when the proper amount has been added the alloy is stirred rapidly and immediately poured into molds. Care must be taken that the calcium does not float on the surface of the aluminum, as in this case it would rapidly burn to the oxid without formation of alloys. After the melted aluminum has been removed from the fire, the introduction of each calcium piece produces a reaction which generates sufficient heat to keep the alloy in a melted condition until all the needed calcium has been added.

The alloys are especially useful for the manufacture of light castings for automobiles, aeroplanes, etc. (1,224,362, May 1, 1917.)

#### Iron and Steel

**Ferro-alloys and High Speed Steel.**—Two patents of ISADOR LADOFF, of Wilkinsburg, Pa., deal with the production of ferroalloys and high speed steel. The first (No. 1,221,873, April 10, 1917), describes a method of making ferroalloys by heating a mixture of the oxides of the metals in proportions calculated to insure the desired percentage of the metals in the alloy. Thus, for instance, uranium, chromium, vanadium, and iron oxide, may be used. To this mixture is added an auxiliary oxide such as arsenic, antimony, nickel, or cobalt. The charge is then heated below the melting points of the metals in the presence of a reducing agent until the desired alloy has been produced. The auxiliary oxide mentioned above is claimed to render the alloying metals more miscible and therefore more readily alloyable. The second patent (No. 1,221,874, April 10, 1917) describes the production of high speed steel by producing in one heat a preliminary quaternary alloy of ferro-metal with tungsten, chromium and vanadium in the proper proportions and then melting the alloy in a bath of ferro metal not comprised in the alloy. The tungsten-chromium and vanadium constitute not less than 50 per cent of the preliminary alloy, which is produced by reducing the oxides of the constituent metals at temperatures below their melting points.

**Youngstown Chemists' Club.**—The Youngstown Chemists' Club closed a very successful season with a dinner Wednesday evening, May 16, followed by an excellent program. Mr. F. E. Dodge, chief chemist of the Barrett Co. gave a most interesting impromptu talk on "The Benzol Situation," Prof. H. E. Whitfield of the University of Western Australia and British Inspector of Materials at Pittsburgh, explained some of the British methods of testing the materials for shells and other munitions. Mr. W. C. Anderson, chief chemist of the American High Explosive Co. of New Castle, Pa., spoke on "The Chemistry of High Explosives and Permissibles," exhibiting some very interesting samples.

**Illinois Mining Engineers' Meeting.**—The Illinois Mining Institute and Chicago Section of the American Institute of Mining Engineers held a joint meeting and field trip May 17, 18 and 19, with headquarters at La Salle, Ill., at the Hotel Kaskaskia. A meeting was held on Thursday afternoon, May 17, and a reception Thursday evening. Meetings were also held on Friday morning and evening, and a joint dinner Friday evening. On Friday afternoon and all day Saturday inspection trips were made to various plants and points of interest. The excursions included the works of the Marquette, Lehigh and German-American cement companies, the mines of the Illinois Zinc Co. and the La Salle County Carbon Coal Co., and the zinc smelting works of the Matthiessen & Hegeler Zinc Co., the Illinois Zinc Co. and the Mineral Point Zinc Co. These works produce spelter, sheet zinc, sulphuric acid, zinc oxide and acid phosphate.



## The Supply of Platinum

The known supply of metals of the platinum group in the world is possibly 5,000,000 ounces. Estimates based on the official figures of production from Russia since 1843, which are taken as 25 per cent too low, and on the assumption that Russia has supplied 95 per cent of the world's output, indicate that the total quantity of crude placer platinum produced in the world since 1843 has been less than 4,632,000 troy ounces, or about 159 short tons.

Crude platinum is not pure, as it contains, besides iron, small amounts of one or all of the metals iridium, palladium, osmium, rhodium, and ruthenium. It is difficult to estimate the quantity of platinum in the world, but it is perhaps within reason to say that the platinum in the world's stock of metals of the platinum group amounts to 4,000,000 ounces.

From the most reliable information in the hands of the United States Geological Survey, it is estimated that the total quantity of platinum in the United States is about 1,000,000 ounces, besides which there is over 400,000 ounces of other metals of the platinum group, principally palladium, iridium, and rhodium.

In 1916 the crude platinum mined in Colombia, estimated at 25,000 ounces, was refined in the United States, and reports received from domestic refiners show that 28,088 ounces of metals of the platinum group was recovered by them from all sources, foreign and domestic, of which 24,518 ounces was platinum.

ESTIMATED WORLD'S PRODUCTION OF CRUDE PLATINUM, 1909-1916, IN TROY OUNCES

Country	1909	1910	1911	1912
Borneo and Sumatra.....	500	200	.....	.....
Canada .....	30	30	30	30
Colombia .....	6,000	10,000	12,000	12,000
New South Wales and Tasmania .....	440	332	470	778
Russia .....	264,000	275,000	300,000	300,000
United States .....	672	390	628	721
	271,642	285,952	313,128	313,529
Country	1913	1914	1915	1916
Borneo and Sumatra .....	200	.....	.....	.....
Canada .....	50	30	100	60
Colombia .....	15,000	17,500	18,000	25,000
New South Wales and Tasmania .....	1,500	1,248	303	222
Russia .....	250,000	241,200	124,000	63,900
United States .....	483	570	742	750
	267,233	260,548	143,145	89,932

\*No basis for estimate.

It is known that the Colombian deposits will be more extensively developed during 1917 than ever before, and it is estimated that at least 30,000 ounces of crude platinum, containing 85 per cent metal, will be derived from that source. It is hoped that in 1917 deposits in the United States will yield more platinum than heretofore, that platinum derived from all sources other than foreign crude may exceed 7000 ounces, and that the production of crude platinum will be at least 10 per cent greater than in 1916.

The Russian situation is very difficult, but it is known that there are considerable stocks of crude platinum held in Russia which are available to the allied governments. It is believed that the production from Russia in 1917 will be considerably increased, perhaps equaling the 1915 output.

Apparently the normal requirements of platinum in the United States call for 165,000 ounces a year, part of which is supplied by refining scrap and sweeps from the various industries using platinum. It is estimated that the dental industry formerly used between 25 and 30 per cent of the supply, part of which cannot be considered as recoverable. However, dental manufacturers are now using a number of alloys in place of platinum. It is estimated that the jewelry industry uses between 40 and 50 per cent of the supply, practically all of which would be recoverable if necessity arose.

There is no available information concerning the quantity of platinum in chemical utensils in the many hundred laboratories throughout the United States, but it is probably not much over 10 or 15 per cent of the supply and is all recoverable.

In 1915 about 44,000 ounces, or 4 per cent of the apparent United States stock of platinum, was used in contact-process sulphuric acid works. The acid made in these plants is very strong, and its use at this time is limited practically to munition makers. The production of sulphuric acid of grades in use in ordinary chemical industry does not depend on catalytic platinum, as such acid is made in lead chambers. The output of contact-process plants has increased nearly 200 per cent since 1915, and it is understood that plants using this process are not yet operated to their full capacity. It therefore would not appear that there is any pressing need for a large supply of platinum by the sulphuric-acid industry.

The Government laboratories are apparently well supplied with platinum utensils, and are not in the market for platinum at present, except as investigations on a larger scale may require new equipment. The United States mints are known to refine platinum and doubtless have stocks sufficient to meet any immediate governmental requirements.

A census of stocks of unmanufactured platinum in the United States that can be considered as immediately available is now being taken by the United States Geological Survey. From the information already available it would appear that there are supplies of platinum sufficient to meet such extensions of contact-process plants as may be required immediately.

From the foregoing statements the available supply of platinum in the United States appears to be adequate to meet immediate needs, but it should be emphasized that new demands may arise at any time which the present stocks of platinum in this country could not meet.

The jewelry industry has voluntarily agreed to limit the use of platinum in jewelry during the war.

It may be advisable to state that industrial expansion in the future may make necessary the further curtailment of platinum in the manufacture of jewelry in order that an adequate supply of this metal, which is essential in many chemical industries, may be assured.

**Metallurgical Fellowships.**—Dean Milnor Roberts of the College of Mines, University of Washington, announces that twenty applications for the mining and metallurgical research fellowships offered by the U. S. Bureau of Mines in connection with the University College of Mines, have been received. Winners of the scholarships will receive \$720, and will conduct extended research study along lines of mining and metallurgical work that will be of special importance to the Pacific Northwest and Alaska.

**Wood Oils.**—The Forest Products Laboratory, Madison, Wis., has recently conducted considerable experimental work on wood oils. In the refining of crude hardwood distillates, the tar is distilled with steam to recover the acetic acid and alcohol, and during the distillation some light-gravity, low-boiling oils are also distilled over. These are commonly called "wood oils." It has been known for some time that these oils possessed very valuable solvent properties, but the very disagreeable odor and the permanent yellow color were very disadvantageous. It has been found by the Forest Products Laboratory that, by hydrogenation, the color can be very much improved and the odor changed to a distinctly agreeable ketone odor, and that this can be done without any marked change in the other physical or chemical properties.

### A New Dry Concentrator

A new type of dry concentrator known as the Elsol concentrator has been designed and placed on the market by Young & Tyler of Los Angeles, Cal. It is stated that successful results have been obtained on gold, silver, lead, zinc, copper and antimony ores with this machine. A diagram is given in Fig. 1.

Ore from the hopper *C* is fed onto a specially constructed metal surface *F*, over which is a cover with pipe *K* attached, connected to settling cone *B*.

The bottom side of all riffles are perforated with a nozzle-like perforation placed at such angle as to not only give the lifting effect on the material (thus allowing the values having the higher specific gravity to settle to the bottom), but also to aid in a more rapid advance of the material along the riffles.

The exhaust, which draws fine dust up through pipe *K*, is furnished by connecting the return air pipe *E* to the tank *B*. The fine dust is discharged at *H*.

The riffles of the concentrator are of an obtuse angled V-shape with one side—the front or bottom side—longer than the other, and when in its working position a cross-section presents an appearance similar to that of the lip of an ordinary gold pan when being used by an expert panner.

At the upper or feed end of the table these riffles are of comparatively large cross-section and gradually taper down to a small cross-section at the concentrate-discharge end *G*. The object of this is twofold: It gives a greater longitudinal angle to the upper riffles, besides reducing the capacity per unit length of riffle as the discharge end is approached.

The greater longitudinal angle has the effect of holding the values more securely once they have been caught, since the riffle cuts more sharply across the line of travel of the table movement. The reduction of cross-section has the positive effect of eliminating the gangue matter which may be riding near the top of the riffle.

The table movement is accomplished by a set of eccentrics which together with a relatively high rotation give the rapid progressive movement of the material.

The concentrator is built in capacities ranging from 1 to 12 tons per hour on coarse crushed quartz ores, and from 2 to 40 tons per hour on ordinary gold placer. The

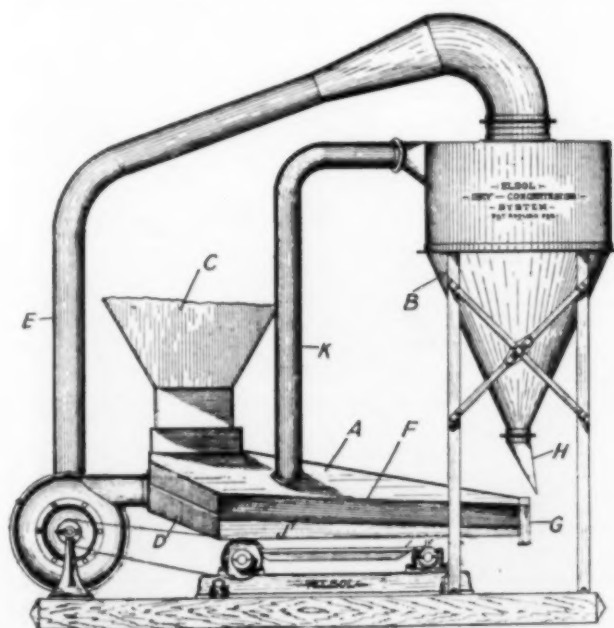


FIG. 1—DIAGRAM OF DRY CONCENTRATING SYSTEM

capacity depends largely on the quality of the ore and upon the percentages of values carried, the lower the percentage of values the higher the capacity.

It is claimed that the horsepower required varies from less than 1 on the small size to 2½ to 3 on the larger sizes.

### Oxy-Illuminating Gas Lead Burning Apparatus

Apparatus for lead-burning with oxygen and natural or artificial illuminating gas, known as "Astra" apparatus, has been developed by Ashton, Laird & Company of New York, and is being placed on the market through



PORTABLE WELDING APPARATUS

its agents, the Bradford-Ackermann Corporation, Forty-second Street Building, New York.

Two standard models are made, a stationary and a portable type. The portable type is shown in Fig. 1. It includes a flexible metallic gas hose connected to the gas main and oxygen tank and to the regulator and torch, as shown. A working range of 18 ft. is provided by the hose, which can be increased by means of additional hose.

A specially designed pressure-reducing valve, with safety attachment, serves as the oxygen regulator. This is supplied with a gage to indicate the working pressure at the burning nozzle. A high-pressure gage, furnished separately, can be attached to determine the initial contents of the oxygen tank when received, or when it is nearly exhausted, or the quantity of gas used in each operation. The apparatus also includes an oxygen back-pressure release valve for the illuminating-gas line. This device, and the safety device on the oxygen regulator, operate automatically, and are provided with alarm whistles to attract attention.

The two-hose torch is provided with a valve, as shown, which can be used to shut off the oxygen supply between operations, leaving only the illuminating gas as a pilot light.

The apparatus is so assembled that its different component parts may be added to existing welding, or decarbonizing apparatus to provide lead burning facilities. Other Astra appliances may be added in order to include hard soldering, brazing, tempering, etc.

### A New Hardness Tester

An instrument designed by Dr. Leonard Waldo for determining the hardness of metals under service conditions is shown in the illustration Fig. 1. The requirements of such an instrument are that it should be easily portable and that its indications should be uniform over indefinite periods of time, and subject to easy calibration.

The instrument consists of a plummet weighing 1/10 lb. and falling 1 ft. to the surface of the material whose hardness is to be measured. This plummet *P* shown in the illustration has a conical, replaceable, chill-tempered, 60 deg., steel point *G*. This plummet has tied to its upper extremity a very thin silk thread which bends over a funnel-shaped end piece *ABC*, into which, at *A* and *B*, slotted holes are cut with burnished edges such that the silk thread passes through them with practically no friction loss. The funnel *ABC* turns with a slight friction in the end of the jointed supporting brass tube *IC*. The silk thread is attached to a small burnished ring at its lower end, which ring in turn is caught in a little trigger at *H*, which can be released by the thumb screw *I* without jarring the instrument. The silk thread then passes from the release catch *K* through the hole *A*, through *B*, through an adjustable third hole at *E*, which is clamped in place by the thumb screw *D* so that the plummet point *G* is exactly over the aperture *O* in the base of the instrument.

The base of the instrument is supported on three points, two of which are controlled by leveling screws *J*. Small cross levels indicate the verticality of the supporting rod *IC*.

In use, the instrument is set on the surface of the material whose hardness is to be tested, so that the aperture in its base *O* is concentric with the exact spot to be tested. The plummet is then hung as shown, and lowered by holding the

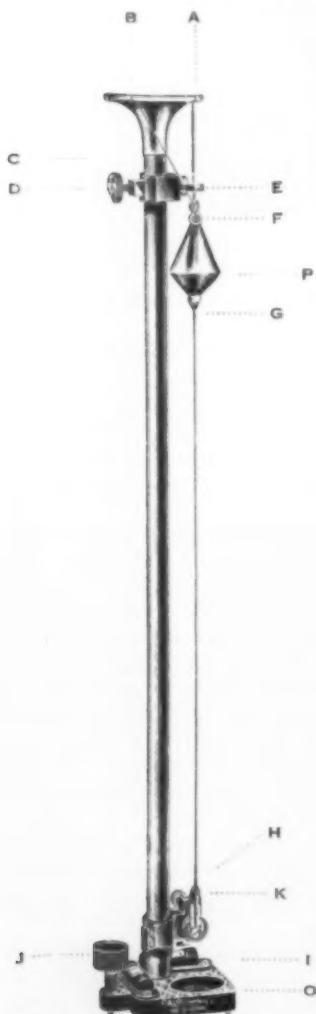


FIG. 1—WALDO HARDNESS TESTER



FIG. 2—SMALL PORTABLE MICROSCOPE

silk thread by its ring between the fingers so that the exact position of the clamp *DE* may be found for insuring the vertical fall of the plummet. This being determined, with the instrument leveled, the thread ring is placed in its releasing trigger *H*, and with the plummet in its position *FG*, the funnel support *AB* is gently turned until the distance from the conical point *G* to the surface of the material to be tested *O* is exactly 1 ft.

When the plummet is still the trigger is released by the thumbscrew *H*, and the plummet falls, making a uniform circular indentation in the material tested. The object in releasing the plummet from the bottom of the apparatus is to avoid disturbance in its upper support. A small portable microscope (Fig. 2) is then used. It is designed so that it has sufficient illumination and magnifying power to measure easily with an eyepiece micrometer the diameter of the impression made by the falling plummet point. A scale for measuring indentations is embodied in the microscope.

The apparatus is being placed on the market by the Palo Company, 90-94 Maiden Lane, New York City.

### Cooling Condensing Water in a Dyestuff Plant

The desire for quick and rapid production of new dyestuffs and other chemical products in order to take advantage of the markets has made it necessary for a great many plants to adopt makeshifts for certain of their operations, which while giving the desired result would probably not be considered if the element of time did not enter so strongly into the work. The illustration, Fig. 1, shows a method adopted by one of the large vegetable dye concerns to cool the water used to condense vapors arising from the various processes. The method has been in successful operation since last October, cooling 200 gal. of water per minute from a boiling temperature to 70 to 90 deg. Fahr. The trough on the tank is 22 in. wide and its lip is 15 ft. from the reinforced concrete tank. The tank itself is about 20 ft. x 30 ft., and is 13 ft. deep.

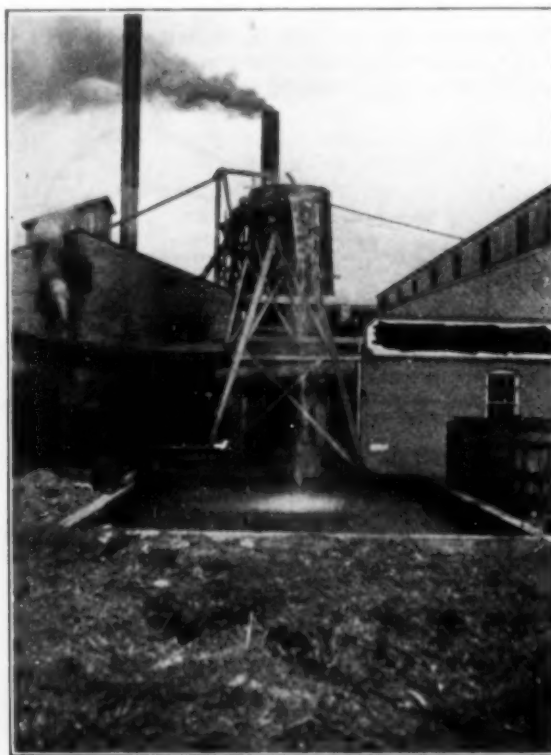


FIG. 1—HOT WATER TANK AND COOLING POND



### Personal

Dr. Marston T. Bogert has been granted leave of absence from Columbia University and is devoting all his time to the work of the National Research Council, of which he is chairman of the Chemistry Committee. His headquarters are in the Munsey Building, Washington, D. C.

Dr. Allerton S. Cushman, president of the Institute of Industrial Research, Washington, D. C., has been commissioned a major in the Officers' Reserve Corps, and will do special research work under the ordnance section on the chemistry of high explosives.

Mr. B. A. Foley has terminated his connections as assistant manager with the Palo Company, and is now associated with the Lenz Apparatus Company, Inc., 9-11 East 16th Street, New York.

Mr. H. A. Ford has resigned his position as steam engineer with the Bethlehem Steel Co., South Bethlehem, Pa., to become assistant superintendent of the Union Carbide Co.'s plant at Sault St. Marie, Mich.

Mr. J. H. Herron has been elected president of the Cleveland Engineering Society. Messrs. S. T. Wellman and Ambrose Swasey, both past presidents, have been made honorary members of the society.

Mr. Bernard MacDonald has accepted an engagement which will occupy his time indefinitely as consulting engineer with headquarters at Antofagasta, Chile.

Mr. Edwin S. Pettis of the Oliver Continuous Filter Company, San Francisco, Cal., was recently in New York on business for his company. He reports great activity in the chemical field.

Mr. E. Gybbon Spilsbury sailed on June 5 for Central America and expects to be absent until the middle of July.

Mr. V. C. Suckow, chief inspecting engineer with Falkenburg & Laucks, Seattle, Wash., has received a captain's commission in the Engineers' Corps and has reported for duty at the Presidio at San Francisco.

Mr. F. H. Tackaberry has been appointed traveling representative of the American Steel Export Co. of New York. He has recently been associated with the Ordnance Engineering Corporation of New York and has occupied important executive positions in such organizations as the Industrial Underwriters, Inc., the Locke Steel Belt Co., etc.

### Book Review

**Standard Methods of Chemical Analysis.** Edited by Wilfred W. Scott. Octavo (15 x 23 cm.), 864 pages, 145 illustrations. Price, \$6.00 net. New York: D. Van Nostrand Company.

This dignified volume is intended for general reference for analytical chemists and advanced students. The editor is research chemist for the General Chemical Company, and has associated with himself seventeen competent specialists.

Part I takes up alphabetically the determination of the elements, all sections being written by Mr. Scott except "Cerium and Other Rare Earths," "Zirconium" and "Thorium," by R. Stuart Owens, "Chlorine" with the assistance of W. F. Doerflinger, "Copper" with the assistance of W. G. Derby of the Nichols Copper Company, "Gold" and "Silver" by W. G. Derby, "Nickel" by W. L. Savell, "Platinum and Allied Rare Metals" by R. E. Hickman of Bishop & Company, "Potassium and Sodium" by W. B. Hicks of the U. S. Geological Survey, "Tin" by H. A. Baker and B. S. Clark of the American Can Company, "Titanium" with the assistance of L. E. Barton of the Titanium Alloy Manufac-

turing Company, and "Zinc" by F. G. Breyer of the New Jersey Zinc Company.

Part II deals with special subjects, in which Mr. Scott himself writes on "Acids," D. K. French on "Water Analysis," A. H. Gill on "Fixed Oils, Fats and Waxes" and on "Gas Analysis," H. A. Gardner and J. A. Schaeffer on "Paints," R. K. Meade on "Cements," J. C. Olsen on "Alloys," F. E. Hale on "Coal" and W. G. Derby on "Assaying."

We find Part I more satisfactorily written than Part II. Under each element the treatment is broad and comprehensive, giving the general bases for determination of the element under varying conditions and in different combinations. The book would have been highly satisfactory if it had ended with Part I. The second part is sketchy and less satisfactory. Many special problems, such as the analysis of foods, asphalts, alloy steels, ferro-alloys, etc., which really require special treatment, are not touched, while those subjects which are treated are not always handled satisfactorily, e.g. alloys and assaying.

The book, as a whole, deserves a place in every chemical laboratory.

## CURRENT MARKET REPORTS

### The Iron and Steel Market

The lapse of a fortnight has furnished additional basis for the view expressed in last report that the steel market had gotten onto a new tack, with less disposition on the part of buyers to contract for late deliveries and less tendency for prices to advance.

The steel market, however, has always displayed an ability to cover up its tracks at a juncture like this, and the present is no exception. There develops, let us say, an indisposition on the part of buyers to contract for deliveries as far ahead as formerly, whereupon the sellers accept the situation and make not the slightest effort to encourage buyers by making price concessions, as they know perfectly well that such action would have the opposite effect. Meanwhile the demand for early deliveries continues on the part of those not fully covered, and as the early deliveries usually command premiums, the average price at which business is done tends to advance at a time when buyers are really displaying less confidence in the future. This is approximately the situation to-day. Some steel products are bringing higher prices than recently, for early deliveries, while ordinary forward buying is light.

The Steel Corporation's unfilled tonnage statement indicates that the volume of obligations on books is equal, in tonnage, to its production for nine months. The larger independents are in somewhat the same position. Some departments are sold much farther ahead, some not as far ahead. Obviously the buyer is taking a long chance in placing a contract for delivery after the present business is filled. The country may then be at peace or it may be facing the prospect of one or two years more of war. A period of market quietness is to be expected, even though consumption may be likely to continue at its present rate. Of this, however, there certainly must be considerable doubt.

The condition as to steel market prospects beyond the next few months is certainly a complicated and confusing one, and not the less so by the ready adoption in some quarters of various fallacies. On the one hand the urgent need for ships is taken as indicating heavy demand for steel for shipbuilding, while the corollary, that if ships are very scarce it will be difficult to export steel, is not considered. Again, the demand for steel for government account, building ships, making tent stoves, camp ranges, helmets, a thousand and one things,

is taken as adding so much to the total demand for steel, without allowance being made for the fact that all the steel must be fabricated or worked up in one way or another, largely with existing facilities, which to that extent can no longer be employed in fabricating the steel they have lately been taking. A factory working up steel may have its tonnage consumption reduced by its being turned onto Government work. The business is not necessarily so much addition. Another fallacy is that each ton the Government takes will correspondingly decrease the total supply of steel. As the industry is highly specialized, only so much steel can be put into sheets, so much into plates, into wire, and so on. Assume a manufacturer who makes a ware from sheets and bars in equal tonnages. Let the Government take sheets and not bars. For every ton of steel, in the sheet form, the Government takes, the factory consumes two tons less steel, because it cannot get the ton of sheets and therefore does not want the ton of bars either.

#### STEEL FOR GOVERNMENT

The Government requirements in steel are not being formulated rapidly. Some opinions must be altered. It has been found undesirable for the Government to buy steel and farm it out to factories and shops for conversion into the useful product. The purchases are to be made of the finished products, and it takes time to make them, so that the steel orders are percolating through to the steel mills rather slowly, in point of tonnage. When it is considered, however, that with a long war the business represents in each case not so much a specific tonnage as a rate per month, to be continued indefinitely, the proportion of the country's steel output that eventually will be passing to Government account seems likely to be larger than was at first estimated. Two months ago an altogether outside estimate was 20 per cent of the total output. If export shipments can be made freely to our Allies and things work well in the matter of finding fabricating capacity to turn rolled steel into useful forms the proportion may in time exceed 20 per cent and may conceivably reach 30 or 40 per cent.

#### STEEL PRICES

There is no longer any well-defined steel market. Formerly there were well-recognized prices for finished steel products for forward delivery, this developing practically into "delivery at mill convenience," but these prices first became nominal and then disappeared altogether. It is a question of tonnage, delivery and specification, every order with a price of its own. Roughly speaking, for delivery from three to six months hence tank plate is 7c. to 8c., with ship plates, Lloyd's specifications, in the neighborhood of 10c.; bars, 4c. to 4.25c.; structural shapes, 4c. to 4.50c.; blue annealed and black sheets, 7c. to 8c., galvanized sheets about 10c.; wire nails, \$3.50 to \$3.75. There is no tin plate market. The respectable mills, practically all, are devoting their output to taking care of the perishable food crops and have nothing to offer.

#### PIG IRON'S INNING

What was suggested a fortnight ago as possible, seems to be coming rapidly to pass. It is pig iron's inning. Throughout this movement, until very lately, the thin neck of the bottle was the steel making capacity. There was plenty of pig iron for the steel-making departments and plenty of rolling capacity—except in plates—for the ingots. Lately, conditions have been changing. Steel-making capacity has increased much more than blast-furnace capacity, and it is impossible for all the furnaces in blast to maintain full output continuously on account of shortage of coke, through car shortage

in the Connellsville region and at coal mines supplying by-product ovens. This is the trade's interpretation of the sharp advances in pig iron. In the past fortnight the following advances have occurred: At valley furnaces, Bessemer, \$5; basic, \$3; foundry, \$2; foundry at Birmingham, \$2; at Philadelphia, \$1; at Chicago, \$3. Last sales of Bessemer were at \$50, valley, 35,000 tons altogether, while last sales of basic were at \$45, but at this writing there does not appear to be any more available and by June 15th the market may be established by sales at more than \$50 for each grade. It may be remarked that while higher than present prices for pig iron ruled late in the Civil War and for two or three years thereafter, \$50 Bessemer iron is the highest in recorded history, as there was no Bessemer iron at that time, as the market commodity, the first reported production of Bessemer steel having been in 1867, a couple thousand tons.

#### Non-Ferrous Metal Market

*Friday, June 8.*—Copper remains virtually unchanged. Tin has declined following a decline in London. Lead has been advanced \$10 per ton by the Trust. Spelter is unchanged. Antimony has declined further on freer offerings. Silver has advanced slightly.

*Copper.*—Prices for prompt and June copper remain practically unchanged with Electrolytic averaging 31.50 cents and Lake 32.50 cents. The strike at Jerome, Arizona was settled June 4, and 1500 men returned to work. At the time of writing no announcement has come of the prices to be paid for copper purchased by the Government. A census is undoubtedly being taken of the possible production during the year and of consumers' requirements. July electrolytic is offered at 31.50 to 32.00 cents, third quarter at 30.00 cents and fourth quarter at 29.00 cents.

*Tin.*—The market in London declined considerably the first week in June, but on June 7 began to recover. Our prices followed those abroad and spot Straits dropped from 65.00 cents on May 28 to 60.50 cents on June 6, but recovered to 61.00 cents on June 7. The market has been quiet and futures have been very dull. The uncertainty as to the tax and the British regulations have had a dampening effect, but it is hoped that the Tin Committee, appointed as a sub-committee of the Council of National Defense will straighten out the tin situation. At present the committee is obtaining data on stocks and requirements of consumers. Arrivals for May were good, totalling 5895 tons. Deliveries at Atlantic and Pacific ports were 4200 tons.

*Lead.*—The trust price of lead was advanced to 10.50 cents New York on June 7. The advance was expected and follows a long period of scarcity of supplies. It is reported that increased production in this country and in Mexico should have its effect before long in the lead market, although there are no signs yet of any let up in demand.

*Spelter.*—Buying continues very dull with spot spelter unchanged at 9½ cents New York basis. It is understood that production is on a smaller scale. Futures up to fourth quarter are quoted at the same figure as prompt shipment.

*Other Metals.*—Antimony has declined from 23.25 on May 28 to 20.75 on June 7. There has not been much demand for prompt, but futures are in good demand. For July shipment 19.00 cents is asked and 18.00 cents for August. Aluminium is unchanged at 60.00 cents for No. 1 Virgin. Magnesium can be had at \$2.25 to \$2.50 for prompt shipment, and for less on contract. Quicksilver is \$90.00 per flask. Pure platinum is \$105 per ounce. Silver is 75⅜ cents per ounce. Tungsten concentrates are \$17.00 per unit for wolframite and \$17.50 for scheelite.



### Chemical Market

**Coal-Tar Products.**—Business in practically all items under this classification has been much restricted during the past two weeks, due to the general unsettled conditions prevailing. The possibility of a 10 per cent duty on free and dutiable goods tends to hold up transactions on English products, and the uncertainties governing war purchases on the other hand tend to restrict offers of domestic materials entering into the manufacture of munitions.

**Benzol.**—In contrast to the situation that prevailed only a short time ago, supplies of benzol have been quite abundant during the interval, and even the large producers have found difficulty in disposing of their holdings. Consequently, there has been but little activity noted, and the market has exhibited a rather weak tone, with some tendency to firmness at the moment of writing.

**Aniline Oil.**—The situation has been rather peculiar. After a period of extreme firmness for more than a month the demand experienced a lull, and a holder of one car possessed the product for more than a week without selling it. As soon as this material was cleared from the market, however, a feeling of firmness ruled, and the market advanced somewhat. Generally speaking, the outlook for aniline oil is bright, and there is a probability that higher prices are to prevail. Some producers who dropped out when low prices ruled have come back, and are now offering in a moderate way.

**Monochlorbenzol.**—There has been nothing of special note to report regarding this product. Supplies have increased and offerings have in some instances been made on a much lower level than any heretofore prevailing. Production now is quite important, and will probably increase.

**Toluol.**—In contrast to benzol, the toluol market is quite stiff, and prices have ruled on a higher level. In anticipation of important government business, holders are not inclined to dispose of their holdings, and have, turned down big business. Prices have been stiff.

**Toluidines.**—There has been no important change to record with important sales noted of *para*, with *ortho* somewhat restricted in demand. Mixed *toluidine* has practically disappeared from the market, although some inquiry is still noted.

**Phenol.**—The production continues to increase and in excess of the demand. Middle Western producers have been offering at prices somewhat below those prevailing in the East, and producers generally do not appear to be very well pleased with the situation, which has shown practically no important movement for months past.

**Dinitrophenol.**—Offerings of this product have been restricted. Values have remained moderately firm, but nothing of special importance has transpired.

**Naphthalene.**—English flakes are still offered at low prices in bond, but do not appear to attract much consuming inquiry. Prime domestic flakes are rather firm, but are not changed materially since our last report.

**Paradichlorbenzol.**—To use a pun, this product is a drug on the market. As a by-product, supplies are accumulating rapidly, and some holders have expressed a willingness to dispose of holdings at any reasonable price a buyer will set.

**Paranitrophenol.**—The manufacture of this product appears to be confined to one source, and there is good demand reported at favorable prices. *Ortho*, on the other hand, drags, and sales are difficult.

**Heavy Chemicals.**—Business has been small and unimportant during the intervals, with prices generally higher, but in some instances notably lower.

**Bleaching Powder.**—An extremely weak condition prevails, due it is stated to an important production by consumers from their own cells.\* There has been little export business, and the paper mills have been reselling contracts.

**Caustic Soda.**—In contrast, the market for caustic rules high, but the speculative interest is still pronounced, and it is predicted that when this element is eliminated a break will occur.

**Soda Ash.**—The market has not been particularly strong. A fair demand has prevailed, but prices remain about stationary. Some inquiry for 1918 has prevailed. Dense ash is in urgent demand, and high.

**Formaldehyde.**—The market has probably reached its highest point. It continues strong, however, but there seems to be little likelihood of any consumer paying more than present record prices.

**Zinc Oxide.**—A sharp advance has occurred, and supplies continue very scarce, with many important inquiries still unfilled.

**Cyanides.**—With the exception of potassium, all grades have ruled weaker in face of important Japanese competition.

**Copper Sulphate.**—While business has not reached important proportions, prices rule steady, and producers are quite firm in their views.

**Barium Compounds.**—There has been a rather brisk inquiry for these products, particularly the carbonate.

**Carbonate of Potash.**—Short interests find difficulty in covering. Their supplies are very light and prices high.

**Acetate of Soda.**—The demand has improved materially, and more money has been secured.

**Phosphate of Soda.**—Offerings have not been as free as heretofore and the commercial variety shows an advance in price.

**Acids.**—All grades of *acetic* are higher, with supplies scarce. There has been more activity noted in *maricatic*, and prices are higher in some directions. *Nitric* has been higher, due to the increased cost of raw materials rather than to any increased activity. *Sulphuric*, both pyrites and brimstone, has been firm and fairly active. *Oleum*, however, is somewhat off, owing to an increased output.

### General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET JUNE 7, 1917

Acetic anhydride.....	lb.	1.70	—	1.80
Acetone, drums.....	lb.	.27	—	.27½
Acid, acetic, 28 per cent.....	lb.	.05	—	.05½
Acetic, 50 per cent.....	lb.	.09½	—	.10
Acetic, glacial, 99½ per cent, carboys.....	lb.	.31	—	.32
Boric, crystals.....	lb.	.11	—	.11½
Citric, crystals.....	lb.	.73½	—	.75
Hydrochloric, commercial, 18 deg.....	lb.	.01½	—	.01½
Hydrochloric, 20 deg.....	lb.	.01½	—	.01½
Hydrochloric, C. P., conc., 22 deg.....	lb.	.01½	—	.01½
Hydrofluoric, 30 per cent, in barrels.....	lb.	.04	—	.05
Lactic, 44 per cent.....	lb.	.11	—	.12
Lactic, 22 per cent.....	lb.	.04½	—	.05
Nitric, 36 deg.....	lb.	.06½	—	.07
Nitric, 42 deg.....	lb.	.07½	—	.08
Oxalic, crystals.....	lb.	.46	—	.47
Phosphoric, 85 per cent.....	lb.	.33	—	.37
Picric.....	lb.	.70	—	.75
Pyrogallol, resublimed.....	lb.	3.50	—	4.00
Sulphuric, 60 deg.....	ton	20.00	—	22.00
Sulphuric, 66 deg.....	ton	30.00	—	35.00
Sulphuric, oleum (Fuming), tank cars.....	ton	35.00	—	40.00
Tannic, U. S. P., bulk.....	lb.	.45	—	.50
Tartaric, crystals.....	lb.	.70	—	.82
Alcohol, grain, 188 proof.....	gal.	3.06	—	3.08
Alcohol, wood, 95 per cent.....	gal.	1.00	—	1.02
Alcohol, denatured, 180 proof.....	gal.	.72	—	.73
Alum, ammonia lump.....	lb.	.04	—	.04½
Alum, chrome ammonium.....	lb.	.18	—	.19
Alum, chrome potassium.....	lb.	.30	—	.32
Alum, chrome sodium.....	lb.	.12	—	.12½
Alum, potash lump.....	lb.	.06½	—	.07
Aluminium sulphate, technical.....	lb.	.02	—	.02½
Aluminium sulphate, iron free.....	lb.	.03	—	.03½
Ammonia aqua, 26 deg. carboys.....	lb.	.06½	—	.07
Ammonium carbonate.....	lb.	.13	—	.14
Ammonium nitrate.....	lb.	.16	—	.17
Ammonium, sulphate domestic.....	lb.	5.80	—	5.90
Amyl acetate.....	gal.	4.00	—	4.25
Arsenic, white.....	lb.	.18	—	.19
Arsenic, red.....	lb.	.30	—	.60
Barium chloride.....	ton	80.00	—	90.00
Barium sulphate (Blanc Fixe, powder).....	lb.	.04	—	.04½
Barium nitrate.....	lb.	.11	—	.11½
Barium peroxide, 80 per cent.....	lb.	.27	—	.27½



Bleaching powder, 35 per cent chlorine	lb.	.02	.02 1/2
Borax, crystals, sacks	lb.	.08	.08 1/2
Brimstone, crude	ton	45.00	—
Bromine, technical	lb.	.80	.90
Calcium, acetate, crude	lb.	.03	.03 1/2
Calcium, carbide	ton	80.00	90.00
Calcium chloride, 70-75 per cent, fused, lump	ton	26.00	28.00
Calcium peroxide	lb.	1.80	1.90
Calcium phosphate	lb.	.30	.31
Calcium sulphate	lb.	.01	.02
Carbon bisulphide	lb.	.04 1/4	.04 1/2
Carbon tetrachloride, drums	lb.	.15 1/4	.16
Caustic potash, 88-92 per cent	lb.	.85	.86
Caustic soda, 76 per cent	100 lb.	6.40	6.45
Chlorine, liquid	lb.	.15	.18
Cobalt oxide	lb.	1.55	1.60
Copperas	100 lb.	1.05	1.10
Copper carbonate	lb.	.33	.35
Copper cyanide	lb.	.72	.74
Copper sulphate, 99 per cent, large crystals	lb.	.00 1/2	.10
Cream of tartar, crystals	lb.	.48	.49
Epsom salt, bags	100 lb.	4.25	4.50
Formaldehyde, 40 per cent	lb.	.17	.18
Glauber's salt	100 lb.	.65	.70
Glycerine, bulk, C. P.	lb.	.61	.62
Iodine, resublimed	lb.	3.50	—
Iron oxide	lb.	.02	.08
Lead, acetate, white crystals	lb.	.16	.17
Lead arsenate	lb.	.12 1/4	.13 1/2
Lead nitrate	lb.	.17	.18
Litharge, American	lb.	.08	.19
Lithium carbonate	lb.	1.02	1.05
Manganese dioxide, U. S. P.	lb.	.55	.60
Magnesium carbonate, tech.	lb.	.13	.14
Nickel salt, single	lb.	.14	.14 1/2
Nickel salt, double	lb.	.11	.12
Phosphorus, red	lb.	1.12	1.15
Phosphorus, yellow	lb.	1.25	1.30
Potassium bichromate	lb.	.35	.36
Potassium bromide granular	lb.	1.00	1.05
Potassium carbonate calcined, 80-85 per cent	lb.	.60	.70
Potassium chlorate, crystals	lb.	.56	.57
Potassium cyanide, 98-99 per cent	lb.	2.15	2.20
Potassium iodide	lb.	2.90	2.92
Potassium murate 80-85 p. c. basis of 80 p. c.	ton	375.00	400.00
Potassium nitrate	lb.	.30	.34
Potassium permanganate	lb.	4.00	4.10
Potassium prussiate, red	lb.	2.60	2.70
Potassium prussiate, yellow	lb.	.96	1.05
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	350.00	375.00
Rochelle salts	lb.	.37 1/2	.38 1/2
Sal ammoniac, gray gran.	lb.	.11	.12
Sal ammoniac, white gran.	lb.	.17	.18
Sal soda	100 lb.	1.10	1.20
Salt cake	100 lb.	.90	1.00
Silver cyanide	oz.	.70	—
Silver nitrate	oz.	.46 1/4	—
Soda ash, 58 per cent, light, flat	100 lb.	2.80	3.00
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	4.00
Sodium acetate	lb.	.09	.10
Sodium benzoate	lb.	5.60	5.50
Sodium bicarbonate, domestic	100 lb.	2.10	2.20
Sodium bicarbonate, English	lb.	—	—
Sodium bichromate	lb.	.15	.15 1/2
Sodium bisulphite, powd.	lb.	.03 1/2	.04
Sodium chloride	lb.	.23 1/2	.25
Sodium cyanide	lb.	.70	.75
Sodium fluoride, commercial	lb.	.13	.14
Sodium hyposulphite	lb.	.01 1/4	.02
Sodium nitrate, refined	lb.	.05 1/2	.05 3/4
Sodium nitrite	lb.	.39	.43
Sodium peroxide	lb.	.90	.95
Sodium phosphate (tri.)	lb.	.04 1/2	.04 3/4
Sodium prussiate, yellow	lb.	.39	.31
Sodium silicate, liquid—40 deg. Baumé	100 lb.	1.50	1.60
Sodium sulphide, 30 per cent crystals	100 lb.	1.55	1.70
Sodium sulphide, 60 per cent, fused	100 lb.	2.60	3.00
Sodium sulphite	lb.	.03 1/4	.03 1/2
Strontium nitrate	lb.	.28	.30
Sulphur chloride, drums	lb.	.06	.06 1/2
Sulphur dioxide, liquid, in cylinders	lb.	.12	.14
Sulphur, flowers, sublimed	100 lb.	3.20	3.30
Sulphur, roll	100 lb.	2.55	2.60
Sulphur, crude	ton	45.00	46.00
Tin bichloride, 50 deg.	lb.	.19 1/4	.20
Tin oxide	lb.	.66	.70
Tungstic acid, basis 100 per cent	lb.	1.40	1.50
Zinc carbonate	lb.	.25	.27
Zinc chloride	lb.	.10 1/4	.11
Zinc cyanide	lb.	.50	—
Zinc dust, 350 mesh	lb.	.18	.20
Zinc oxide, American process XX	lb.	.17	.20
Zinc sulphate	lb.	.06	.03 1/2

### Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.55	.60
Benzol, 90 per cent	gal.	.57	.59
Toluol, pure, water white	gal.	1.90	2.00
Xylol, pure, water white	gal.	.50	.55
Solvent naphtha, water white	gal.	.17	.20
Solvent naphtha, crude, heavy	gal.	.13	.16
Cresote oil, 25 per cent	gal.	.31	.33
Dip oil, 20 per cent	gal.	.24	.30
Pitch, various grades	ton	8.00	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	1.10
Carbolic acid, crude, 50 per cent	lb.	.55	.60
Carbolic acid, crude, 25 per cent	lb.	.30	.32
Cresol, U. S. P.	lb.	.25	—

### Intermediates, Etc.

Alpha naphthylamine	lb.	.90	1.05
Aniline oil	lb.	.29	.31
Aniline salts	lb.	.34	.35
Anthracene, 80 per cent	lb.	.10	—
Benzaldehyde	lb.	4.50	5.00
Benzidine, base	lb.	1.85	2.00
Benzidine, sulphate	lb.	1.65	1.70
Benzoic acid	lb.	5.50	7.00

Benzyl chloride	lb.	2.00	2.10
Beta naphthol benzoate	lb.	14.00	16.00
Beta naphthol, sublimed	lb.	.70	.75
Beta naphthylamine com.	lb.	2.50	—
Dichlor benzol	lb.	.22	.23
Dinitrochlorbenzol	lb.	.46	.48
Dimethylaniline	lb.	.55	.60
Diphenylamine	lb.	.95	1.00
H-acid	lb.	3.25	3.50
Metaphenylenediamine	lb.	1.60	1.65
Monochlorbenzol	lb.	.28	.32
Naphthalene, flake	lb.	.00 1/2	.10
Naphthionic acid, crude	lb.	1.50	1.75
Nitro naphthalene	lb.	.45	.50
Nitro t. s. u. l.	lb.	.55	.60
Ortho-aminodiphenol	lb.	—	—
Ortho-toluidine	lb.	1.00	1.15
Para-aminodiphenol, base	lb.	5.00	6.00
Paranitraniline	lb.	1.15	1.20
Paraphenylenediamine	lb.	3.50	3.75
Para toluidine	lb.	1.90	2.00
Phenol, U. S. P.	lb.	.40	.42
Resorcin, technical	lb.	8.50	9.00
Resorcin, pure	lb.	16.00	17.00
Salicylic acid	lb.	1.15	1.20
Salol	lb.	1.70	1.75
Sulphanilic acid	lb.	.31	.33
Tolidin	lb.	3.00	—
Toluidine-mixture	lb.	.80	.85

### Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.10	—
Corning, Ohio	bbl.	2.40	—
Somerset, Ky.	bbl.	2.20	—
Wooner, Ohio	bbl.	2.18	—
Indiana	bbl.	1.78	—
Illinois	bbl.	1.92	—
Oklahoma and Kansas	bbl.	1.70	—
Caddo, La., light	bbl.	1.90	—
Corseana, Tex., light	bbl.	1.70	—
California	bbl.	.78	.87
Gulf Coast	bbl.	1.00	—

### Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13 1/2	.14
Cylinder, light	gal.	.21	.26
Cylinder, dark	gal.	.18	.19
Paraffine, high viscosity	gal.	.29 1/2	.30
Paraffine, 903 sp. gr.	gal.	.21 1/2	.22
Paraffine, 865 sp. gr.	gal.	.18 1/2	.19

### Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25 1/2	—
Pine-tar oil, double refined, sp. gr. 0.965-0.980	gal.	.35	—
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.980	gal.	.19	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.00-1.08	gal.	.19	—

### Vegetable and Other Oils

China wood oil	lb.	.16	.16 1/2
Cottonseed oil, crude	gal.	1.11	—
Linseed oil, raw, cars	gal.	1.20	—
Peanut oil, crude	gal.	1.15	—
Rosin oil, first run	gal.	.38	—
Rosin oil, fourth run	gal.	.67	—
Soya bean oil, Manchuria	lb.	.14 1/2	—
Turpentine, spirits	gal.	.49	—

### Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	40.00
Barytes, floated, white, domestic	ton	28.00	32.00
Beeswax, white, pure	lb.	.55	.60
Carnauba wax, flor.	lb.	.51	—
Casoin	lb.	.19	.28
Chalk, light, precipitated, English	lb.	.03	.06
Feldspar	ton	8.00	12.00
Fuller's earth, powdered	100 lb.	1.00	1.50
Ozokerite, crude, brown	lb.	.60	.70
Ozokerite, American	lb.	.35	—
Red lead, dry, carloads	lb.	.12	—
Rosin, 280 lb.	bbl.	6.40	—
Soapstone	ton	10.00	12.50
Talc, American, white	ton	10.00	13.00
White lead, dry	lb.	.10 1/2	—

### Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal	—
Chrome cement, Grecian	net ton	60.00	—
Clay brick 1st quality fireclay	per 1000	45.00	—
Clay brick, second quality	per 1000	30.00	—
Magnesite, raw	ton	30.00	35.00
Magnesite, calcined	ton	40.00	55.00
Magnesite, Grecian, dead burned	net ton	90.00	—
Magnesia brick, Grecian, 9x4 1/2 x 2 1/2	net ton	140.00	—
Silica brick	per 1000	45.00	—

### Ferroalloys

Ferrochromium	lb.	Nominal	—
Ferromanganese, domestic, delivered	ton	425.00	450.00
Ferromanganese, English	ton	200.00	—
Ferromolybdenum, per lb. of Mo.	lb.	4.25	—
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	240.00	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.00	—
Ferrovanadium, f.o.b. works	lb.	3.25	3.50

# INDUSTRIAL

Financial, Construction and Manufacturers' News

## Financial

### New Companies

Argus Mining Company, Sandpoint, Idaho, has been incorporated with capital of \$800,000, and L. E. Myers, G. B. Hoyt, W. D. Boyce, incorporators, to buy, sell and lease mines and mining property, coal and timber lands, operate sawmills, power plants and smelters.

Azadon Corporation has been incorporated with a capital of \$140,000 to acquire and market petroleum. The incorporators are F. D. Buck, M. L. Harty, K. E. Longfield, Wilmington, Del.

Bassick Company, Bridgeport, Conn., has been incorporated with a capital of \$6,000,000 to manufacture iron and steel, copper, wood and other material.

The Bellwood Foundry & Machine Company, Bellwood, Pa., has been incorporated with a capital of \$20,000. Geo. C. Bland of Tipton, incorporator.

B. Brown & Bro., Inc., New York City, has been incorporated with a capital of \$100,000 to deal in and manufacture oils, chemicals and colors. The incorporators are J. C. Brown, D. R. Bernstein, I. Skutch, 998 Sterling Place, Brooklyn.

California Burdett Oxygen Company has been incorporated with a capital of \$500,000 to manufacture oxygen, hydrogen and other gases. The incorporators are H. E. Latter, H. M. Robinson, C. M. Egner, Elkton, Md.

Central Glass Company, Delaware, has been incorporated with a capital of \$1,000,000 to manufacture glass of all kinds. The incorporators are H. E. Latter, C. H. Rimplinger, C. M. Egner, local Wilmington incorporators.

Chemical Securities Company has been incorporated in Delaware with \$7,500,000 capital. Will conduct an investment business.

Commercial Iron & Steel Corporation, Delaware, has been incorporated with 1000 shares of no par value. J. R. Munoz, representative, 115 Broadway, New York.

The Corrugated Fibre Mills, Inc., Brooklyn, N. Y., has filed articles of incorporation with capital of \$100,000 to manufacture paper corrugated and fiber board. J. B. Golan, L. Levine and J. C. Cassett, 27 Pine Street, New York, are the incorporators.

The DeWano Chemical Company, Newark, N. J., has filed articles of incorporation with capital of \$25,000 to manufacture chemicals. The incorporators are Nathaniel A. Clinger, William G. Amdur and William H. Reardon.

J. E. Dockendorff & Co., Inc., New York, has been incorporated with a capital of \$500,000 to manufacture iron, steel, copper and wood articles. The incorporators are J. E. Dockendorff, R. A. Young, J. R. Clark, Jr., 120 Broadway.

The Dodge-Weldon Iron Company, 15 Exchange Place, Jersey City, N. J., has filed articles of incorporation with capital of \$540,000, to operate mining properties. The incorporators are: Andrew L. Meyer, 322 West 145th Street, New York, and Harry Osborne, 1297 Putnam Avenue, Brooklyn; Joseph F. Simpson, 440 Riverside Drive, New York.

Elliott-Blair Steel Company, Pittsburgh, Pa., has been incorporated with a capital of \$500,000 to deal in steel. The incorporators are George D. Blair, N. W. Elliott, Thomas C. Elliott, New Castle.

Fine Colors Company, Van Houton Street, Paterson, has been incorporated with a capital of \$30,000 to manufacture lake and pigment colors.

Fish Products Company, Inc., New York, has been incorporated with a capital of \$200,000 to manufacture oils and fertilizing materials. The incorporators are E. Seligman, W. G. Weichmann, A. Jaretski, Jr.

Gasoline Oil Refining Company, New York, has been incorporated with a capital of \$2,500,000 to drill and bore for oil and natural gas. The incorporators are F. D. Buck, M. L. Harty, K. E. Longfield, of Wilmington, Del.

Gibson Consolidated Copper Company, New York, has been incorporated with a capital of \$1,000,000. The incorporators are

Allen E. Moore, George F. Jebbitt, F. H. Buethorn, of New York.

The International Marine Welding Company, Dover, Del., has been incorporated with capital of \$200,000 by New Jersey interests to operate a welding plant to specialize in marine work. The incorporators are Charles R. Stewart, Roy T. Anderson, Ridgewood, N. J., and David H. Wilson, Jr., Franklin Township, N. J.

The Jaffrey Manufacturing Company, Trenton, N. J., has been incorporated with a capital of \$50,000 to manufacture chemicals. The incorporators are Benjamin D. Phillips, New York; Harry H. Umberger, and L. E. Conover, both of Trenton.

Kellogg Products Company, Inc., Buffalo, N. Y., has been incorporated with a capital of \$2,500,000 to manufacture margarines, vegetable oils, soaps, glycerine, chemicals. The incorporators are S. Kellogg, S. Kellogg, Jr., and H. Kellogg, Buffalo.

Keystone Iron & Steel Works, Los Angeles, Cal., has been incorporated with a capital of \$500,000. The incorporators are J. E. Geyer, W. S. McGiffert, A. A. Barton, J. P. Loftus and W. F. Allen.

The Koal-Oak Fuel Company, Fresno, Cal., has been incorporated with a capital of \$20,000.

The Lincoln Brass Foundry Company, Chester, Pa., has been organized to operate a local brass foundry. F. W. Mathues, Swarthmore, is the principal incorporator.

Lone Fire Mining Company, Ogden, Utah, has been incorporated with a capital of \$50,000. The incorporators are J. S. Lewis, G. W. Williams, F. Melsner, J. S. Lewis.

The Loxol Manufacturing Company, Lebanon, Pa., has been incorporated with a capital of \$100,000 to manufacture cement, paint, polish, insulators, spark plugs and kindred products. The incorporators are R. B. Locke, L. O. Demers, P. A. Painchaud, T. J. West, Jr., and A. O. Painchaud.

Lutz Chemical Corporation, New York, has been incorporated with a capital of \$1,000 to deal in drugs, chemicals, etc. The incorporators are D. A. Lutz, A. Brandt, Emil Tucker.

Manila Copper Mining & Smelting Co., Spokane, Wash., has been incorporated with a capital of \$2,000,000. The incorporators are H. Ostrander, H. W. Lefevre, T. J. Neely, L. P. Edge and F. L. Middleton.

The Manufacturers Iron & Steel Company, New Brunswick, N. J., has been incorporated with a capital of \$3,000,000 to manufacture iron and steel products. The company will take over and operate the plant of the Neverslip Manufacturing Company, New Brunswick, manufacturer of horseshoes and calks, as well as the plant of the Bryden Horseshoe Company, Cataungua, Pa. The incorporators are James W. Johnson, William J. McCurdy and Robert C. Nicholas.

The Merigold Electro-Plating Company, Newark, N. J., has been incorporated with a capital of \$10,000 to operate a plant at 97 Chestnut Street. The incorporators are John L. Merigold, L. M. and Oliver J. Sizelove.

The Nassau Smelting & Refining Works, 503 West Twenty-ninth Street, New York City, has filed articles of incorporation with capital of \$1,000,000 to specialize in the production of materials for foundry use. R. and L. Lowenstein and I. H. Livingston, all of New York, are the incorporators.

National Sulphur Company, Inc., Hornell, N. Y., has been incorporated with a capital of \$900,000 to manufacture and refine sulphur and deal in chemicals. The incorporators are C. B. Zabriskie, 119 East Nineteenth Street; H. L. St. John, 270 Riverside Drive; and A. E. Beggs, 876 Carroll Street, Brooklyn.

Navajo-Pacific Copper Company, Delaware, has been incorporated with a capital of \$60,000,000 to do general mining, milling, refining and marketing of copper, lead, zinc, gold, silver and all other ores and metals. The incorporators are A. W. Britton, S. B. Howard, L. H. Gunther, H. B. Davis, Jos. F. Curtis, all of New York.

Northern Graphite Corporation, New York City, has been incorporated with a capital of \$250,000 to do mining, milling, concen-

trating ores, etc. The incorporators are G. A. Alonzo, S. Banome, R. Loudon, 2 Rector Street.

The Northwest Magnesite Company, 607 Hutton Building, Spokane, Wash., was incorporated May 10, 1917, with a capital of \$1,000,000. The incorporators are B. L. Thane, R. B. Adams, R. S. Talbot and Seabury Merritt. The officers are R. S. Talbot, president; S. F. B. Morse, vice-president; B. L. Thane, consulting engineer; Seabury Merritt, secretary, and D. J. Murphy, treasurer. The company's properties are located about 6 miles from Chewelah, a town on the Great Northern Railroad, situated about 60 miles north of Spokane. Operations were commenced in November, 1916, and about 4000 tons have been shipped. The company will build either a narrow-gauge railroad or aerial tramway to the properties. Two rotary kilns, 125 ft. long and 7 ft. 6 in. in diameter are now being installed for calcining the raw magnesite. The capacity of the plant will be about 4500 tons per month.

The Nu Process Gasoline Company, Dover, Del., has been incorporated with a capital of \$300,000 to manufacture refined oils. Robert McKnight, F. M. Neepner and A. M. Neepner, all of Pittsburgh, are the incorporators.

Owens & Phillips, Inc., New York, has been incorporated with a capital of \$150,000 to deal in chemicals and fire extinguishing compounds. The incorporators are A. R. Latson, Jr., T. E. Smith, E. L. Tamblin, 424 First Street.

Phenix Sulphur Corp., Delaware, has been incorporated with a capital of \$1,000,000 to mine for and dispose of sulphur, gypsum, etc. The incorporators are M. Egner, H. E. Latter, H. M. Robertson, of Wilmington, Del.

The Allen W. Phillips Smelting Company, Attleboro, Mass., has been incorporated with a capital of \$50,000. The incorporators are A. W. Phillips, Charles Bloss, Dr. Louis Millet, Thomas G. Sadler.

Quaker-Hill Blue Lead Mines Company, Delaware, has been incorporated with a capital of \$3,500,000, to acquire mines and conduct general mining business. The incorporators are H. E. Latter, C. L. Rimplinger, C. M. Egner, Wilmington, Del.

The Quito River Mining & Dredging Company has been incorporated by Robert L. DeGroff and associates in Delaware with capital of \$500,000, to operate mining properties. Other incorporators are S. Woodhull, West Orange, N. J., and Roswell S. Nichols, Westfield, N. J.

Reslow Chemical Company, Newark, N. J., has been incorporated with a capital of \$10,000 to manufacture and deal in chemicals and drugs. The incorporators are E. P. Scheck, L. Fisher, L. A. Mills, Montclair.

The Rush Chemical Company, Pittsburgh, Pa., has been incorporated with a capital of \$100,000 to manufacture chemicals, etc. The incorporators are Arthur E. Young, R. Ratcliffe, N. N. Hackett, Grant Curry and E. D. Young, all of Pittsburgh.

Schoen-Jackson Company, Pittsburgh, Pa., has been incorporated with a capital of \$5000 to deal in iron and steel. The incorporators are A. R. Bassett, W. H. Schoen, M. R. Jackson.

The Superior Iron & Steel Corporation has been incorporated in Dover, Del., with a capital of \$3,000,000 to manufacture iron and steel products. The incorporators are Horace G. Eastburn, Artemas Smith and M. E. Doto, all of Wilmington.

Texas Chemical Company, Houston, Tex., has been incorporated with a capital of \$100,000. The incorporators are G. F. Howard and E. E. Thomas of Houston and S. Feiser of San Francisco.

Thor Steel Corp., New York City, has been incorporated with a capital of \$100,000 to operate steel mills. The incorporators are H. Van Arsdale, Jr., L. A. Watson, C. J. Kulberg.

The Tottenville Copper Company, Inc., Richmond, Staten Island, has been incorporated with a capital of \$1,000,000 to operate smelting and refining works. The company has its plant and office on Church Street, Tottenville. B. Lowenstein and I. Livingston are the incorporators.

Tucker-Watney Corporation, New York, has been incorporated with a capital of \$100,000 to operate steel mills. The incorporators are C. J. Kulberg, L. A. Watson, H. Van Arsdale.

United States Metals Refining Corporation, Inc., New Jersey, has been incorporated with a capital of \$4,000,000 to develop mines. Representative, F. Y. Robertson, 120 Broadway.

The United States Magnesite Company of Spokane has been incorporated to work deposits in the magnesite district of Stevens County. The company has capital stock of



\$100,000, and incorporators are Charles P. Oudin and Charles V. Bob. This is the third concern organized for mining magnesite in Stevens County.

The Universal Pipe Line Oil & Producing Co., Delaware, has been incorporated with a capital of \$5,000,000 to erect refineries of all kinds. The incorporators are F. D. Buck, M. L. Horth, J. D. Frock.

Universal Ramie Fiber Company, New York, has been incorporated with capital of \$10,000,000 to chemically compound and treat greases and growths of fibrous and kindred nature. The incorporators are C. Madden, Hiram Cavannagh, F. H. Coulson, all of New York.

The Utility By-Products Chemical Co., 790 Broad Street, Newark, N. J., has been incorporated with a capital of \$50,000 to manufacture chemicals.

Virginia & Ohio Manufacturing Company, Wilmington, Del., has been incorporated with a capital of \$50,000. The incorporators are Herbert B. Latter, C. L. Rimlinger, Clement M. Egner, Wilmington.

Vulcan Iron & Steel Company, Paden City, W. Va., has been incorporated with a capital of \$300,000. The incorporators are Thomas Watson, George R. Wallace, E. B. Power, S. L. McConaughy, and W. B. Elchleay, all of Pittsburgh, Pa.

Warner-Caldwell Oil Co., Delaware, has been incorporated with a capital of \$1,000,000 to mine and bore for petroleum and natural gas. The incorporators are H. E. Latter, C. L. Rimlinger, C. N. Egner.

The Washington Mold Machine & Foundry Company, Washington, Pa., has been incorporated with a capital of \$25,000 to operate a local plant. Charles Bromley is the principal incorporator.

Wasson Securities Corporation, New York, has been incorporated with a capital of \$362,300 to manufacture iron and steel. The incorporators are M. M. McMahon, L. L. Rohr, A. E. Connelly, 5 Nassau Street.

The Waterloo Refining Co., Delaware, has been incorporated with a capital of \$1,250,000 to bore for natural gas, oil, etc., and market and refine the same. The incorporators are M. L. Horthy, K. E. Longfield.

Western Producing & Refining Co., Tulsa, Okla., has been incorporated with a capital of \$100,000. The incorporators are C. H. Overton, R. K. Hughes, M. J. McNulty.

Wilbur Mining & Milling Co., Dover, Del., has been incorporated with a capital of \$200,000 to carry on general mining, milling and refining business. The incorporators are L. B. Phillips, J. B. Bailey.

Wilde & Co., Boston, Mass., has been incorporated with a capital of \$25,000. The incorporators are F. R. F. Ellis, Brookline; Charles Perkins, Chicago; W. H. Nash, Boston.

Wildwoods Oil & Sulphur Co., Wilmington, Del., has been incorporated with a capital of \$100,000. The incorporators are F. O'Keefe, George G. Steigler, E. E. Wright of Wilmington, Del.

The Williams & Crowell Color Co., Providence, R. I., has been incorporated with a capital of \$20,000 to manufacture and deal in dyes and colors. The incorporators are Joseph R. Williams of Pawtucket, H. H. Crowell of Sterling, Conn., and Edwin Knowles of Providence.

Wyoming United Oil Refining Company, Chicago, has been incorporated with a capital of \$3,000,000 to bore for oil, produce and dispose of petroleum and its products. Incorporators are R. H. Holton, J. A. Massen, M. M. Hunt, all of Chicago.

### Capital Increases, Etc.

The Consolidated Motors Corporation of Philadelphia, a Delaware corporation, has increased its capital from \$1,500,000 to \$2,500,000 for expansion.

The National Folding Box & Paper Company, 132 Franklin Street, New York, has increased its capital from \$1,000,000 to \$2,000,000 for expansion.

The Perkins Foundry Company, Amsterdam, N. Y., has increased its capital from \$20,000 to \$50,000 for extensions.

The Crystal Chemical Company, Bronx (New York City), N. Y., has increased its capital from \$100,000 to \$200,000 for expansion.

The National Fuel Gas Company, 26 Broadway, New York, a New Jersey corporation, has filed notice of increase in capital from \$16,000,000 to \$32,000,000 for expansion.

The Oliver Chemical Company, Trenton, N. J., with registered office at Perth Amboy, has increased its capital from \$10,000 to \$125,000 to provide for business extensions.

The New Jersey Paper Tube Company, Nordhoff, N. J., has increased its capital

from \$25,000 to \$90,000 for expansion. Louis S. Coe, president.

The Tennessee Chemical Company has applied for a capital increase from \$200,000 to \$1,000,000.

The Ohio Steel Products Company, Mineral Ridge, Ohio, has increased its capital stock from \$70,000 to \$100,000.

The Jackson Furnace & Foundry Company, Jackson, Mich., has increased its capital stock from \$20,000 to \$70,000.

The Macbeth-Evans Glass Company has increased its capital stock from \$2,000,000 to \$5,000,000 for extensions and improvements.

States Chemical Company, Chicago, has increased its capital to \$25,000 from \$2,500.

## Construction and Operation California

SAN FRANCISCO.—The paint and varnish works of the Bass-Hueter Point Company is being enlarged by the addition of a three-story building.

SAN FRANCISCO.—The Pacific Coast Steel Company is contemplating moving from San Francisco to Oakland. The reason given for this is that better transportation facilities are provided in Oakland than in San Francisco. The company is considering constructing a large factory in Oakland to take the place of the one it now occupies.

SAN FRANCISCO.—A large plant for the manufacture of citric acid is planned by a group of big retail druggists. It is planned to use culls of oranges and lemons to manufacture the acid and other basic chemicals. The California Pharmaceutical Association is interested in the project.

SAN FRANCISCO.—The Tulare Mining Company is opening up a dolomite mine about four miles east of Coleville. The company will install kilns and other apparatus for the preparation of calined products.

### Connecticut

NEW LONDON.—The Standard Brass & Copper Tube Company will erect an addition to its plant at this place. The company is a subsidiary of the Bridgeport Brass Company.

### Idaho

KELLOGG.—The Bunker Hill & Sullivan Mining Company, Frederick W. Bradley, president, will build an electrolytic zinc plant at Kellogg, Idaho; initial capacity 30 tons of ore per day. The lead smelter just being completed by this company will be ready for operation June 1, and at least one stack will be blown in before that date. Coke for the plant will be obtained from the Pacific Improvement Company of Carbonado, Wash., which will start construction of new coke ovens at once. Lime will be obtained from the company's quarries at Ione, Wash.

### Indiana

FORT WAYNE.—The Huntington Steel Foundry Company will build a two-story addition to its plant on Condit Street.

### Maine

BANGOR.—The Great Northern Paper Company has purchased from the Northern Finance Company water rights, land and other privileges on the Penobscot River. The Great Northern Company plans eventually to build a pulp mill and dam at this place.

### Massachusetts

NEW BEDFORD.—The Taunton-New Bedford Copper Company has obtained a permit to build a brick rolling mill and machine shop which will cost \$200,000.

### Michigan

BAY CITY.—The Roeller Foundry Company has completed an addition to its plant, including a new cupola capable of melting 15 tons of iron per hour. The company makes iron, aluminium and brass castings.

### Missouri

ST. LOUIS.—The Standard Oil Company plans an addition to its Woodriver refinery which will cost about \$2,000,000.

### Montana

ANACONDA.—The Washoe and Great Falls Smelters of the Anaconda Mining Company produced 29,300,000 lb. of copper for the month of April as against 31,300,000 lb. for March. The falling off is due to mine fires, which curtailed production. It

is estimated that the yearly production will total 360,000,000 lb.

HELENA.—The American Smelting & Refining Company has taken over under a bond and lease, on a royalty basis, the Sour Dough group of seven mining claims in the Elkhorn District of Jefferson County. Contract provides that the company must take out not less than 100 tons of ore a day. The smelting company desired the ore for the iron silicate contained, to be used for fluxing purposes. At present the fluxing material for the East Helena smelter is shipped from Utah.

### Nevada

CARSON CITY.—Benjamin Q. P. Foss of Philadelphia is planning a \$75,000 plant near here to produce alcohol from Nevada sagebrush.

### New Jersey

BAYONNE.—The Texas Company has filed plans for the erection of a series of one-story additions to its plant at First Avenue and Avenue A. The work will include a new converter house, experimental plants, and asphalt shop, and will cost about \$16,000.

CAMDEN.—The Lambert & Todd Machine Company, manufacturer of special machinery, will build a two-story addition to its plant on Arch Street. It is proposed to double the capacity of the plant.

HOBOKEN.—M. J. Kearney is planning to increase the capacity of his copper works at 1206 Clinton Street with the removal of his present New York City shops on Twenty-eighth Street to the local plant.

HOBOKEN.—Fire, May 31, destroyed the two-story plant of the Hibbe Chemical Works, Jefferson Street, with loss estimated at \$10,000.

JERSEY CITY.—The Jersey City Cutting & Welding Company, 224 Monmouth Street, has been organized to operate a local plant. John G. Lowe and Christopher Spence are heads of the business.

JERSEY CITY.—The Standard Motor Construction Company, manufacturer of marine and gasoline engines, will build a one-story addition on Whiton Street.

JERSEY CITY.—The Goldschmidt Thermit Company, manufacturer of welding apparatus, is planning for the erection of a one-story addition on Bishop Street to cost about \$10,000.

LINDEN.—The Grasselli Chemical Company, whose head office is Cleveland, Ohio, has been granted a permit to erect a new building here. The new structure will cost about \$36,000 and will be built of brick and steel construction.

NEWARK.—Fire, on May 26, destroyed a portion of the brass foundry of C. A. Goldsmith, 44 Cutler Street.

NEWARK.—The Verona Chemical Company, Verona and Riverside Avenues, has filed plans for the erection of a one-story addition, about 25 x 45 ft.

NEWARK.—Krauter & Company, Inc., 583 Eighteenth Avenue, manufacturer of tools, has filed plans for the erection of a new tool shop and steel works on Nye Avenue, Irvington, to cost \$42,000.

NEWARK.—The Block Chemical Works has filed plans for the erection of a one-story addition on Vesey Street.

NEWARK.—The O. W. Young's Oils, Inc., has leased a two-story building at 33 Ross Street, Newark, and will use same for the refining of oils, greases, lubricants, etc.

TRENTON.—The Delion Tire & Rubber Company has awarded contracts for the erection of two new reinforced-concrete additions to its plant on State Street, to cost about \$17,000. The structures will be 50 x 110 ft. and 25 x 65 ft.

### New York

BUFFALO.—The McDougall Paint Company has leased the property formerly occupied by the Peter A. Voght Manufacturing Company at Water and Norton Streets. After making extensive alterations, the McDougall Paint Company will occupy the property.

BUFFALO.—The Kellogg Products Company, a new \$2,500,000 corporation, has purchased the plant formerly occupied by the Buffalo Paint & Varnish Company and the Certainated Products Company. The directors of the new company are Spencer Kellogg, Jr., Spencer Kellogg, Sr., Howard Kellogg, E. H. Stichel and J. C. Alkman. The company will manufacture margarine, soap, glycerine, edible products and other chemicals. The general offices of the company will be in the Kellogg Building at 98 Delaware Avenue.

CARTHAGE.—The Carthage Sulphite Pulp & Paper Company has purchased additional property for extension of its mills.



### North Carolina

**NEW BERN.**—The New Bern Cotton Oil Mill Company is erecting an addition to its plant on Griffith Street.

### Ohio

**ALLENDALE.**—The Fostoria Pressed Steel Company, incorporated with a capital of \$100,000, will make pressed steel parts for the Allen Motor Company. The plant will turn out complete sheet metal products, including enameling and japanning. The company's new plant will have 20,000 sq. ft. of floor space.

**HAMILTON.**—The plant of the Hamilton Furnace Company at Cokeotto was recently opened after having been closed for almost ten years.

### Oregon

**PORTLAND.**—The Potato Starch Manufacturing Company has been incorporated by Portland capital, headed by J. F. Griffith, and plans the construction of a starch plant near Portland, to be followed later by other plants in the Willamette Valley. The "cull" potatoes will be used in manufacturing the starch, and initial plant will have capacity of 20 tons daily, turning out four tons of starch, besides valuable by-products.

### Pennsylvania

**PHILADELPHIA.**—The Gill Glass Company will erect a three-story, reinforced concrete and brick factory which will cost \$200,000.

**PHILADELPHIA.**—The Philadelphia Paper Manufacturing Company will erect a one-story brick factory building at Nixon north of Fountain Street, costing \$75,000.

**PHILADELPHIA.**—The John Lang Paper Company will erect a five-story addition to the plant here at a cost of \$40,000.

### Utah

**MORONI.**—The new sugar plant now under construction here by the People's Sugar Company is expected to be ready to begin operation by October 1. The managers expect to handle 70,000 tons of beets this season. The plant contains the most modern machinery for the production of sugar from beets.

**SALT LAKE CITY.**—It is reported that the Mineral Products Company is producing 100 to 150 lb. of potash and 300 to 350 lb. of alumina from one ton of rock. A considerable quantity of sulphuric acid is also produced as a by-product.

### Washington

**ANACORTES.**—C. H. Freeman of this city plans immediate development of his molybdenite mining claims near this city, and establishment of concentrate mill. Assays show claims have average run of \$50 per ton. Washington Molybdenite Company has been organized, with C. H. Freeman, president, Herman Hohde, vice-president.

**NORTHPORT.**—The Northport Smelting & Refining Company, of which George S. Bailey is manager, will install building and equipment for the Cottrell process of fume recovery. The estimated cost is \$100,000. C. L. Graves is the engineer in charge.

**SEATTLE.**—Copper ore shipments from Cordova, Alaska, which have been retarded, due to damages to the Copper River & Northwestern Railroad lines by heavy ice jams, will be resumed in the near future. The Tacoma smelter recently received a cargo of 1500 tons of copper ore, which had been mined during the winter and stored in Cordova.

**SEATTLE.**—The Northwest Lead Company, manufacturers of lead pipe, sheet lead and lead specialties, will remove its plant from Portland to Seattle, where it will occupy a building being remodeled to meet its needs. The plant has a capacity of 25 tons of finished product daily. Much new equipment is to be installed, including a 60-ton sheet lead mill and a lead trap machine weighing 13 tons. Besides above-mentioned products the company will manufacture lead-lined pipe, lead wool for calking water and gas mains, glass lead, sash weights and sinkers.

**SEATTLE.**—The American Nitrogen Products Company, Securities Building, Seattle, has started survey work on its proposed power plant and nitrogen products plant on the Sauk-Suiattle River, in Snohomish County, 60 miles from Seattle. The company expects to have all outside work completed by early fall, when plans will be prepared in the local office for the buildings and structures, and construction work will start early next spring. The proposed power plant will cost \$1,000,000, and ultimate development of the project will represent an investment of several million dollars.

The company has a smaller similar plant at La Grande, near Tacoma, which is now producing sodium nitrite. This plant is a preliminary step toward the larger development in Snohomish County. C. F. Graff is president.

**SEATTLE.**—The Pacific Oils Company, engaged in the manufacture of peanut, soya bean, coconut and other vegetable oils, has leased a seven-acre tract on the Duwamish Waterway and will build a factory costing \$250,000, according to Herman Meyer, secretary and manager of the concern. Site is leased for thirty-five years.

**SPOKANE.**—The United Gold Mining Company, according to W. W. Robbins, mine superintendent, plans to replace cyanide by flotation in the dressing of ore in the company's mill at its Oregon properties. A flotation plant with capacity of 75 to 100 tons daily will be installed. Tailings will be stacked and treated by cyanide later.

**VALLEY.**—The American Mineral Production Company's new buildings at Valley, Wash., are being rapidly pushed to completion. Magnesite is being shipped out of Valley at the rate of four cars daily, about half being crude, the remainder the calcined product. New oil-burning kilns are being constructed and shipments will soon be largely increased.

### Wisconsin

**MILWAUKEE.**—The Valley Steel Company, a newly organized concern, will erect a steel plant at St. Francis, three miles from Milwaukee, located on Lake Michigan. The plant will contain two 60-ton open-hearth furnaces, a 24-in. billet mill and a 10-in. merchant bar mill.

### British Columbia

**ANYOX, B. C.**—The Granby Consolidated Mining, Smelting & Power Company plans to install an experimental plant of 100 tons capacity, using the flotation process, to treat millions of tons of siliceous ore which the company has heretofore not used. If successful, a plant of large capacity will be installed. Operations at the Grand Forks smelters have been interrupted by lack of coke supplies, but the full battery of four furnaces at Anyox are now in operation.

**LADYSMITH.**—The Ladysmith Smelter, Ladysmith, B. C., is preparing to handle ore shipments and has laid additional trackage at its yards. The smelter itself is practically ready to commence operations, and ore shipments will arrive shortly from various points on the Island and from mines on the British Columbia Coast.

**TEXADA ISLAND.**—Development of the lime industry on Texada Island, British Columbia, has reached such proportions that the Pacific Lime Company of Vancouver, has taken over a four-masted schooner to carry the product to San Francisco.

**TRAIL.**—The Consolidated Mining & Smelting Company of Canada, operating a large smelter and appurtenant plants at Trail, B. C., plans to more than double the capacity of its sulphuric acid plant, now producing 12 tons daily. Twenty-four furnaces, each of larger capacity than the furnaces built in the last previous year, will be erected, and extension made to the acid furnace building. The chamber building is also being doubled in size. The initial unit covered an area of 3983 sq. ft., built of tile brick and contained two lead chambers and towers. Increase of capacity is necessitated by the enlarged demand for sulphuric acid in the copper, lead and zinc refineries.

**PRINCE RUPERT.**—The Molybdenite Mining & Reduction Company, Prince Rupert, B. C., which owns a large deposit of molybdenite near that city, has built an aerial tram mill and concentrator which will treat 150 tons daily.

## Manufacturers' Notes

**THE BURDETT OXYGEN COMPANY** will open an office in Chattanooga, Tenn., at 410 Market Street, which will be in charge of A. W. Collins, field manager of the company. The Burdett Company has a plant in Chattanooga which works in conjunction with Wilson & Co.

**THE DRIVER-HARRIS WIRE COMPANY** of Harrison, N. J., has filed notice that its name has been changed to Driver-Harris Company. The former name did not comprehensively designate the products of the concern, and while wire makes up an important part of its production, it manufactures largely alloys and pure metals in the form of strip, rods, sheets and castings. This company also manufactures flexible heater cords and wire rope.

**THE ASBESTOS PROTECTED METAL COMPANY** of Pittsburgh announces the temporary closing of its Atlanta and St. Louis offices. This is due to the fact that J. R. Nichols, Atlanta manager, has entered the Officers' Reserve Corps at Fort McPherson, and F. C. Easterby, St. Louis manager, has entered the Officers' Reserve Corps at Fort Riley, Kan. The home office is in the First National Bank Building, Pittsburgh.

**EXPORTS OF ORES FROM PERU TO UNITED STATES.**—The following table, from Commerce Reports, shows the quantity and value of certain minerals exported from Peru to the United States during the calendar year 1916:

Product	Quantity	Value
Tungsten, kilos .....	529,636	\$771,041
Vanadium, tons .....	2,915½	*29,378
Molybdenum, kilos ....	4,412	8,401
Antimony, kilos .....	63,038	6,130
Tin bars, tons .....	1	502

\*Nominal value.

There are no available official statistics showing the total exportation of these minerals during 1916, but inasmuch as nearly all the minerals were exported to the United States during this period the foregoing table represents practically the total quantity. The tungsten exported is largely of 62 per cent concentrates; molybdenum about 90 per cent, and the antimony 58 per cent.

**THE CHARLES A. SCHIEREN COMPANY**, New York, manufacturer of Duxbak waterproof and steamproof leather belting, has recently opened branch offices at 72 Congress Street West, Detroit; 18 South Broadway, St. Louis; 475 South Main Street, Memphis; 272 Marietta Street, Atlanta, in addition to those already established at New Orleans, Dallas, Boston, Philadelphia, Pittsburgh, Chicago, Denver and Seattle.

**RENNERFELT FURNACES.**—Hamilton & Hansell, 17 Battery Place, New York, announce the installation of the following Rennerfelt furnaces: Chill Exploration Co., New York City, 1000 lb. for iron; Central Steel Co., Massillon, Ohio, one-ton for melting ferromanganese.

**NEW ASSAYING FIRM IN SALT LAKE CITY.**—Under the firm name of Black & Deason, a new firm for assaying and chemical analysis will be opened Monday at 165 South Temple Street. William A. Black was originally an Iowa man, but has spent the last twenty-five years in Salt Lake, being for the last eleven years manager of the R. H. Officer assaying firm, with which he has been identified seventeen years. B. W. Deason was born at Park City, and has spent the last twelve years in Salt Lake, eleven of them being as chief chemist of the R. H. Officer Company.

**CONSERVING THE SUPPLY OF TIN PLATE.**—At a recent meeting of the Committee on the Conservation of Tin Plate, held at the Bureau of Foreign and Domestic Commerce, Department of Commerce, it was claimed by certain packers of non-perishable products that the recommendation made by the committee to the wholesale grocers "that they forthwith voluntarily suspend or cancel all contracts for delivery of non-perishable food products in tins, made with canners, and fully relieve the latter from all liability thereunder," would result in grocers canceling unfavorable contracts and suspending others. No evidence of any proposed action of this sort was brought to the attention of the committee, which did not, therefore, feel justified in changing the wording of the clause involved. It was thought advisable, however, to state that the committee, in suggesting the option of cancellation or suspension of contracts, did so with the idea that it might in many cases be mutually agreeable to suspend rather than cancel contracts and that in such cases, suspension would be quite satisfactory. Another point brought out at the meeting was the question of foreign contracts. It was recommended that contracts affecting the military requirements of our own Government and those of our Allies should be given preferred treatment, but that before making deliveries on such contracts manufacturers should obtain documentary proof of the existence of the contracts, the amount of material required thereon, and satisfactory assurance that shipments would be utilized solely in filling such contracts. While the question of perishability of certain products was discussed, it was the sense of the meeting that the present policy of leaving the decision in all such cases to the Bureau of Chemistry, Department of Agriculture, should be continued.

The Department of Commerce in co-operation with the Department of Agriculture has long been earnestly striving to increase the output of tin cans for food containers. To this end it has endeavored to

increase the supply of tin, to secure the continuous movement of the materials entering into tin cans from the place of production to the place of use, and to facilitate the supply and movement of machinery for producing cans. The department desires in every practicable way to promote the present and permanent prosperity of the tin-can industry. There is no possible doubt of the steady and growing demand for its products.

Tin plate is 98 per cent steel and 2 per cent tin. Steel is the backbone of war, and the mills have not been able to keep all their customers fully supplied at all times. Moreover, abnormal freight demands have made prompt deliveries uncertain. There have also been decreased imports of pig tin, due to decreased production and reduced shipping facilities. It is not surprising, therefore, that the tin-plate makers cannot provide the can manufacturers with sufficient plate to enable them to meet the increase in the demand for cans, which is 25 to 40 per cent greater than it was last year.

It is therefore imperative that the available supply of cans be utilized, in so far as possible, for packing products that can be preserved only in tin, and that substitutes be used for other products wherever practicable. Such containers should be cheaper than tin, so that the ultimate benefit from lower costs may offset the initial expense of the substitution.

The price of glass has steadily risen and has reached a point at which any large extension of its use for food containers is impracticable. At present fiber or paper containers of good quality are being produced in considerable and increasing quantities, and for many purposes are supplanting glass and tin plate. The price of the fiber containers depends upon the size, the quality of the paper-pulp material, the number of treatments with paraffin, and the amount of printed matter on the outside. The commoner types may be obtained at 1.25 to 1.5 cents for the half-pint size, 1.25 to 1.6 cents for the pint size, and 1.5 to 1.65 cents for the quart size. Fiber containers are made in various shapes and sizes adapted to different purposes and may or may not be coated with paraffin, which is chemically inert and is sometimes baked into the paper material. Some of these containers are claimed to be air-tight, proof against leakage, and protected from contamination by the paraffin. Some containers appear to be more nearly air-tight than others of the same style, probably because of better fitting covers. These containers are light in weight, pack readily for shipment, are easily opened, and are used but once.

The demand for "ready-to-eat" foods, such as baked pork and beans, spaghetti, etc., with the simple direction "Heat and serve," represents the largest factor in the increased use of tin cans. These foods must be processed in the containers at or above the temperature of boiling water, and no substitute for tin has been found that satisfactorily meets these conditions. However, a great economy in tin can be effected by home cooking of such products during the present shortage.

Fiber containers are recommended for the distribution by the retailer of many foodstuffs, including milk, cream, butter-milk, ice cream, oysters, syrups, marsh-mallow creams, dried fruits, preserves, jellies, mince-meat, horseradish, relishes, pickles, deviled ham and chicken, vinegar, dry and prepared mustard, soda water, salads, sauerkraut, and olives.

It is claimed that dry food products such as coffee, tea, alum, baking powder, spices, raisins and prunes may be successfully packed by producers and manufacturers in paper or fiber containers. For some of those products, bags lined with tinfoil have been in successful use for 10 years or more and they form an attractive package that is said to be moisture proof.

Other commodities usually packed in tin could be marketed as well in paper or fiber, with the advantage of lower cost. Among these tobacco occupies a conspicuous position, and other articles are eye, cleansers, soap powders, shoe polishes, metal polishes, soaps and shaving preparations, toilet articles, such as talcum powder, and various dry drugs and chemicals. Paper containers are also suggested for preserved fruits and jellies made at home. Cloth sacks for tobacco and wood for syrups and molasses are also recommended where retail sales can be made in bulk.

For packers of dry products who are opposed to the adoption of fiber containers because of the good-will built up upon the style and shape of a tin container, fiber containers having a tin top and bottom are available. These containers, when labeled, have the appearance of all-tin cans and are almost as serviceable.

Certain types of these containers are now being tested to determine to what extent the claims of their manufacturers as to their general qualities can be substantiated. Manufacturers of substitute containers who wish their products tested should send samples to the Bureau of Standards, Department of Commerce, with full information regarding commodities for which the containers are specially designed, prices and ability to contract for early deliveries. Names and addresses of firms prepared to supply fiber and other containers may be obtained from the Bureau of Foreign and Domestic Commerce or its district or co-operative offices. Co-operation is required between the Government departments, the manufacturers of tin plate and of substitute containers, the packers of foodstuffs, and of other articles commonly put up in tin, and the general public. If the available supply of tin plate is to be limited to strictly necessary uses and if, at the same time, the largest possible quantity of food is to be preserved against the special needs of the coming months.

**BEEHIVE COKE PRODUCTION IN 1916.**—The production of beehive coke in 1916 was the greatest ever recorded in the United States, and the average value per ton was higher than in any previous year. The official figures for 1916, published by the United States Geological Survey, show that 35,464,224 tons of beehive coke, valued at \$95,468,127, were produced last year. The output in 1916 represented an increase over 1915 of 7,955,969 tons, or 29 per cent, in quantity, and \$38,522,584, or nearly 68 per cent, in value. The average value per ton of the coke used in making beehive coke in 1916 was \$1.26, an increase of 21 cents, or 20 per cent, and the average value of the coke was \$2.69, an increase of 62 cents, or 30 per cent. The number of active beehive ovens in 1916 was 65,605, as against 48,985 in 1915, an increase of 16,620. The number of idle ovens was 25,976, as against 44,125 in 1915. Abandoned ovens numbered 2265, of which nearly 1800 were in Pennsylvania and West Virginia. No new establishments and but 104 new beehive ovens at old works were reported to be under construction at the end of 1916, a low record compared with recent years, especially in view of the high prices and steady demand for coke throughout the year. The coke producers evidently recognize the fact that the day of the beehive oven is passing and that after the present abnormal condition is over most coke will be made in by-product ovens. The official figures showing the production of coke in by-product ovens in 1916 have not yet been compiled.

**INDUSTRIAL SITES ASSOCIATION.**—The Industrial Sites Association of America, 115 Broadway, New York, has been organized for compiling and classifying data concerning the properties, sites, buildings, railroad and water facilities, labor conditions, population, etc., of all towns and cities where manufacturing plants could be advantageously established—a clearing house which would supply manufacturers with complete and verified information free of charge. There are in many parts of the United States many number of cities and towns possessing many superior facilities and natural resources, admirably suited for manufacturing and other industrial purposes. Scarcity of desirable locations is no part of the manufacturers' problem. Their great lack has been a central source of information which would enable them to put their fingers on just what they wanted without traveling from city to city and town to town, spending thousands of dollars and months of valuable time in a fruitless search for factory sites measuring up to their requirements. The officers are E. J. Scriggins, president; E. P. Smith, vice-president, and A. M. Gerow, secretary-treasurer.

**LOUISVILLE INDUSTRIAL FOUNDATION.**—Louisville, Ky., has formed a million-dollar industrial bureau to assist industrial enterprise of all kinds in that locality. The Foundation has offices in the Columbia Building. The Foundation will render financial assistance to worthy industrial enterprises within the limitations and on the basis indicated in the following charter provision: The Foundation shall not invest more than 10 per cent of its capital in any one concern, nor shall it subscribe to more than 33 1-3 per cent of the total cash paid in capitalization of any one concern; and in considering capitalization, patents, franchises, sales rights, good will and similar items shall not be included. The financial assistance offered by the Foundation is not tendered as an inducement, but rather to provide additional working capital and to that extent assure the success of those manufacturers who may select Louisville as a location because of economic advantages available there.

**URGES TRADE AND COMMERCIAL ORGANIZATIONS TO CONTINUE MEETINGS.**—President William Fellowes Morgan of the Merchants' Association of New York has addressed a letter to President Wilson on behalf of the Merchants' Association, asking him to discourage the postponement of conventions. Mr. Morgan's letter is as follows:

"It has come to the attention of the Merchants' Association of New York that there is a tendency to forego the holding of conventions and general commercial meetings by business interests of the country because of a desire to practice alleged economy during the war.

"In our judgment this is a false idea of economy, the application of which will be harmful, rather than beneficial, both to the Government and to the Nation's business. Such gatherings, in our judgment, should be encouraged rather than discouraged, because failure to hold them as usual is likely to create a false impression, to stimulate a lack of business confidence and to discourage mutual co-operation which is so necessary under existing circumstances. Conventions and gatherings of different trades and industries afford an exceptional opportunity on the part of business men composing them to study the effect of the war situation upon industries, so that they may be best equipped to serve the needs of the Government and to serve the normal business of the country. Both business and general conventions also afford exceptional opportunities for patriotic gatherings and the fostering of patriotic sentiment.

"We therefore respectfully suggest that, if in your judgment the continuation of such meetings is beneficial, a public utterance by you to that effect would be of great value and would have a marked influence both in stimulating such gatherings and in perpetuating the results flowing therefrom. It seems to us that if ever the citizens of this country should get together, whether in business or general organization meetings, it is during such a period as that through which we are now passing."

## Manufacturers' Catalogs

**THE DRIVER-HARRIS COMPANY.** Harrison, N. J., has issued a new bulletin form of catalog covering its line of products, with the exception of resistance materials, which are covered in its regular resistance catalog. These new bulletins include Monel metal, pure nickel, wire rope, heater cord, cold rolled steel strip, brass, bronze and phosphor bronze wire and "Nichrome" castings.

**THE CHALLENGE COMPANY.** Batavia, Ill., has issued catalog No. 68, describing wood and steel tanks for all purposes.

**THE DE LAVAL STEAM TURBINE CO.** Trenton, N. J., has issued a booklet on "Progress in Water Works Pumps."

**THE LINK-BELT COMPANY,** Chicago, Ill., has issued Book No. 309, 1917, describing the ideal drive for grain elevators.

**THE NASH ENGINEERING COMPANY,** South Norwalk, Conn., has issued Bulletin No. 7, June 1, 1917, describing hydro-turbine air compressors and vacuum pumps, single-stage type.

**THE DURIRON CASTINGS COMPANY,** Dayton, Ohio, has issued Bulletin No. 106, April, 1917, describing standard pipe, drainage pipe, fittings, valves, cocks, etc.

**THE SMITH GAS ENGINEERING COMPANY,** Lexington, Ohio, has issued an attractive booklet, Catalog No. 10, describing its type "MB" gas producer plants for delivering cold, clean gas from bituminous coal, and other types for anthracite coke, charcoal and lignite for power and fuel purposes.

## Other New Publications

**TEMPERATURE MEASUREMENTS IN BESSEMER AND OPEN-HEARTH PRACTICE.** By George K. Burgess. A Department of Commerce publication, No. 91, issued May 8, 1917, by the Bureau of Standards, Washington, D. C.

**INDUSTRIAL AND CHEMICAL ENGINEERS** is the title of a booklet issued by the Will Corporation, Rochester, N. Y.

**THE EMBRITTLING ACTION OF SODIUM HYDROXIDE ON SOFT STEEL.** By S. W. Parr, Bulletin No. 94, published by the University of Illinois, Urbana, Ill., at the Engineering Experiment Station.

**REPORT ON THE BEET SUGAR INDUSTRY IN THE UNITED STATES.** This report was issued on May 24, 1917, by the Federal Trade Commission, Washington, D. C.





# GRAPHITE ELECTRODES

**Acheson Graphite Company**

Niagara Falls, N. Y., U. S. A.

E. G. Acheson, Ltd., 5 Chancery Lane, London, W. C. 2, England

# Coal Tar Pitch

COAL-TAR PITCH is more resistant than other bituminous materials to chemical reactions such as oxidation.

It is more resistant than other bituminous materials to the solvent action of most acids.

It is absolutely unaffected by prolonged contact with water, in marked contrast with other bituminous materials.

It is very high in dielectric strength.

It can be obtained of any desired consistency from a sticky semi-solid material of  $100^{\circ}\text{F.}$  melting-point to a dry, hard substance of  $300^{\circ}\text{F.}$  melting-point.

Write to the Research Department, The Barrett Company, 17 Battery Place, New York City, for specific information about the physical or chemical properties of Coal-Tar Pitch, with relation to your particular problem.

The *Barrett* Company

New York Chicago Philadelphia Boston  
St. Louis Cleveland Cincinnati Pittsburgh  
Detroit Birmingham Kansas City Minneapolis  
Nashville Salt Lake City Seattle Peoria  
THE PATERSON MFG. CO., LIM-  
ITED: Montreal Toronto Winni-  
peg Vancouver St. John, N. B.  
Halifax, N. S. Sydney, N. S.



## American Dyes for American Dyers

### DYES

American Orange 2 A	Acid Red
Metanil Yellow	Sulphur Brown
Azo Orange	Sulphur Black
Chrysoidine	Nigrosine

### EXTRACTS

Logwood	Aurantine
Hematine	Fustic
Quercitron	Cutch

### CHEMICALS

Soda Ash	Bichromate of Soda
Caustic Soda	Bichromate of Potash
Caustic Potash	Prussiate of Soda
Chloride of Lime	Prussiate of Potash
Chlorate of Soda	Barium Nitrate
Chlorate of Potash	Ammonium Nitrate
Carbonate of Potash	

### INTERMEDIATES

Aniline Oil, Pure	Paranitraniline
Aniline Salt	Phenol, U.S.P.
Benzidine Base	Naphthionic Acid
Benzidine Sulphate	Nitrobenzol
Sulphanilic Acid	Nitrotoluol
Dimethylaniline	Toluidine
Beta Naphthol	Picric Acid
Nitroso Dimethylaniline	

*Let us supply full details*

## MARDEN, ORTH & HASTINGS CO., INC.

(Established 1837)

NEW YORK, 61 Broadway

BOSTON, 225 Purchase Street

CHICAGO, 130 North Fifth Avenue

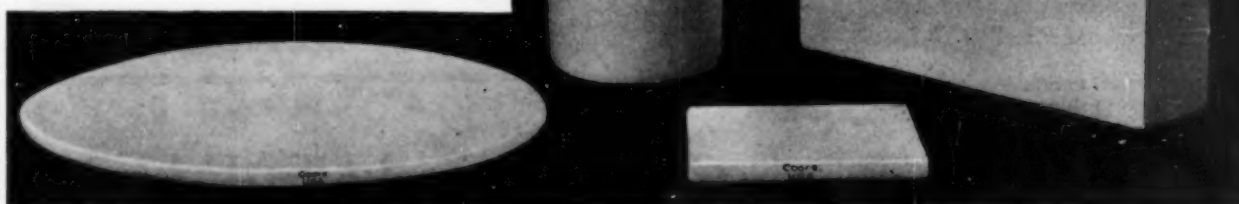
SAN FRANCISCO, 316 Clay Street



# COORS

U. S. A.

## POROUS PORCELAIN



has been the means of solving the filtration and electrolytic problems of several large manufacturing concerns.

Advise us your special needs and we will gladly help you.

**THE HEROLD  
CHINA  
AND POTTERY  
COMPANY**  
GOLDEN, COLO.

## Heraeus Le Chatelier Pyrometers

"The Ultimate Pyrometer"—a slogan earned by their unapproachable record.

Thoroughly interchangeable and accurate to an unusual degree.

Easy to use and entirely practical for severe high-temperature measurement.

Length of service never surpassed by any other instrument and rarely equaled.

### Leaders for twenty-five years

Their relatively high first cost is due wholly to actual material used. For example, the Platinum and Platinum Rhodium Thermo Elements are about a third heavier, length for length, than most others.

The advisability of putting this extra amount into the elements is proven by the fact that maintenance cost on Heraeus Pyrometers rarely exceeds five per cent.

*Send for Bulletin No. 10.*

**Charles Engelhard**  
30 Church St., New York City



# Highest Quality Ferro Tungsten

Do You Analyze Your Ferro-Tungsten?  
If Not, It Would Pay You To Do So—



The value of a product is largely controlled by the purity of the materials of which it is made.

We Guarantee —

Our Ferro-Tungsten to this analysis:

Tungsten.....	70 to 80%
Carbon—not over.....	¼%
Sulphur—not over.....	.05%
Phosphorus—not over.....	.08%

Our facilities are of the very best due to a strictly modern plant and equipment. We are able to offer quick deliveries. Write, Wire or Cable for prices.

**THE VANADIUM-ALLOYS STEEL CO.**  
**LATROBE, PENNA.**

Makers of "Red Cut Superior"—A Quality High Speed Steel

## 99% Pure Metallic Magnesium

Send for Booklet, "Some of the Uses of Magnesium in the Arts," for complete information.

**Norton Laboratories**  
INC.  
Madison Ave. and 41st St.  
New York

## Liquid Sulphur Dioxide

Produced from Pure Sulphur

**ANSUL CHEMICAL COMPANY**  
Marinette, Wisconsin

# CRUDE SULPHUR

Guaranteed 99% Pure

*For use in Metallurgical field, etc.*

**THE UNION SULPHUR CO.**

17 Battery Place, New York City

THE APRIL ISSUE CONTAINS:  
THE POSSIBILITIES OF SMOKELESS OPERATION OF  
HEATING FURNACES AND SOAKING PITS

A Topical Discussion  
BURNING BLAST FURNACE GAS UNDER BOILERS  
A Topical Discussion.

AIR DRYING FOR BLAST FURNACES  
By Leon Cammen, Engr., 29 W. 39th St., New York City.

THE MAY ISSUE CONTAINS:  
IMPORTANT FEATURES RELATING TO THE DESIGN  
AND IMPROVEMENT OF CITY STREETS

By N. S. Sprague, Chief Engr.,  
Bureau of Engineering, Dept. Public Works,  
City of Pittsburgh, Pa.

THE JUNE ISSUE CONTAINS:  
COTTON ROPE FOR POWER TRANSMISSION

By J. M. Allison,  
Engineer, William Kenyon & Sons, Dukinfield, England  
SOME FUNDAMENTALS OF SCHOOL HOUSE DESIGN  
By C. L. Wooldridge, Supt. of School Buildings,  
Board of Public Education, Pittsburgh

PROCEEDINGS  
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

50 cents per copy \$5.00 per year  
ELMER K. HILES, Secretary 568 Union Arcade Bldg.,  
Pittsburgh

CRUDE CRESYLIC

CREOSOTE OILS

## FLOTATION OILS

UNIFORM—TESTED—RELIABLE

Standard Chemical Co.

Tacoma, Wash.

## PINE FLOTATION OILS

Pensacola Tar & Turpentine Company

F. A. Mariner, Pres.

Gull Point, Fla.



*"American  
Actually"*

*Made And  
Available"*



## ALPHA NAPHTHYLAMIN NITRO NAPHTHALIN 1-3-6 ACID

(Naphthylamin Di Sulphonic Acid)

TOLIDIN

ORTHO NITRO TOLUOL  
ORTHO TOLUIDIN

THE MILWAUKEE COKE & GAS CO.

PARA NITRO TOLUOL  
PARA TOLUIDIN

THE NORTHWESTERN IRON CO.

**NEWPORT CHEMICAL WORKS, INC.**

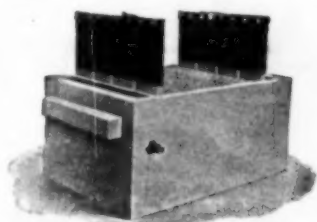
(FORMERLY COKE PRODUCTS COMPANY)

WORKS: CARROLVILLE, WISCONSIN

NEW YORK OFFICE: 120 BROADWAY

RECTOR 7335.

GENERAL OFFICES: FIRST NATIONAL BANK BLDG., MILWAUKEE, WIS.



Type BB Cell

The equivalent of 100 pounds  
of bleaching powder from  
300 pounds of salt

## Electrolytic Cells

We supply several sizes, styles and capacities, for various uses, all of which combine the limit of economy and convenience in the continuous production of bleach.

Quick and profitable results are obtained by our method. Write for full description and prices.

**The Electro Chemical Company**  
DAYTON, OHIO, U. S. A.

Capacity	-	-	-	-	-	+
Floor Space	-	-	-	-	-	-
Power	-	-	-	-	-	0
Sizes	-	-	-	-	-	9

## "Vesuvius"



## Sulphur Burner

Will completely burn any amount of sulphur, depending upon the size of Burner. No sublimation, no dirty fires, no frequent cleaning. All sediment drops to bottom compartment and is easily removed. Determination of quality of gas is readily made without scientific testing instruments. Get specific details.

**Valley Iron  
Works Co.**

Appleton, Wis.



# New Jersey Zinc<sup>o</sup>

## in Brass

**M**ANUFACTURERS of high-grade spun brass and ornamental bronze have found that the safest, surest way to ensure tensile strength, ductility and durability is to use high-grade **Horsehead or Bertha**

Spelter. By reducing the percentage of defective work these sterling spelters have proved their genuine economy for all quality mixtures.

*Horsehead and Bertha Spelter* have had an established reputation for a generation. They are free from cadmium and other impurities.

THE NEW JERSEY ZINC CO., Room 519, 55 Wall Street  
New York

ESTABLISHED 1848

Branch: Mineral Point Zinc Co., 1111 Marquette Building, Chicago, Ill.

## Ferro-Tungsten Powder

CARBON UNDER 0.1 PER CENT.



High Grade — Uniform Quality.

Ideal for Crucible or Electric Furnace.

As supplied to over 60 manufacturers of High-Speed Steel in Sheffield, and to Russia, Japan and Italy.

*All Communications to*

**THE CONTINUOUS REACTION  
CO., LTD.**

HEAD OFFICE:

155 CHURCH ROAD, BATTERSEA, LONDON, S. W. 11.

Cables and Telegrams:  
Conreacto, Battsquare, London.

Telephone:  
918 Battersea.

WORKS:

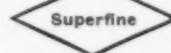
ALTHORPE WORKS, BATTERSEA, LONDON, S. W.  
NEWTON WORKS, HYDE, CHESHIRE

**Buyers of Tungsten Ores**

## Alloys



## Zinc Dust



Any Mesh Highest Purity  
**METALS DISINTEGRATING COMPANY, Inc.**  
3 So. William St., New York Tel. Hanover 377



## MERRILLITE

Supplanting zinc dust for chemical and metallurgical industries

**Merrill Metallurgical Co.**  
121 Second St., San Francisco  
Cable, LURCO



"MINERAL FOOTE-NOTES,"  
monthly, postpaid, is free to consumers  
and brokers; to others 50c. annually.  
Sample copies free to all.

### Some "Fominco" Specialties

<b>BARIUM</b> Carbonate, Chloride, Hy- drate, Sulfate	<b>TANTALUM</b> Tantalite, Oxide, Fluoride
<b>CERIUM</b> Ferro Ore (Monazite)	<b>THORIUM</b> Nitrate Ore (Monazite)
<b>CHROMIUM</b> Chromite Ore, Ferro	<b>TITANIUM</b> Oxide, "Titanellous," Oxa- late
<b>MAGNESIUM</b> Carbonate, Oxide, Metal	<b>TUNGSTEN</b> Ferro, Metal, Ores, Acid
<b>MANGANESE</b> Dioxide, Ferro, Ore	<b>URANIUM</b> Ferro, Oxide, Nitrate, Ores
<b>MOLYBDENUM</b> Sulfide, Ferro, Ammonium Molybdate, Molybdic Acid	<b>VANADIUM</b> Ammonium Metavanadate, Vanadic Acid, Ferro
<b>STRONTIUM</b> Carbonate, Sulfate, Nitrate	<b>ZIRCONIUM</b> Zirkonalba (99% Oxide), Zirkite (80%)

### Commercial Rare Ores and Their Products

Samples and Prices on Request

Established Over Forty Years

## FOOTE MINERAL COMPANY, INC.

109 North 19th Street, Philadelphia, Pa.  
Cable Address, "Foote, Philadelphia"

# Ferro-Uranium

*The Latest Discovery in Alloys for Efficient*

## HIGH SPEED and other STEELS of QUALITY

Largest Producers in the World of Uranium

*Write Us for Particulars*

## STANDARD ALLOYS COMPANY

Forbes and Meyran Avenues, Pittsburgh, Pa.

### FERRO-ALLOYS—Low in Carbon

#### FERRO

—Manganese,	80%
—Silicon,	50%-75%
—Chrome,	65%-70%
—Molybdenum,	70%-80%
—Tungsten,	70%-80%
—Vanadium,	25%-30%, etc.
—Phosphorus,	20%-25%

65-70% Ferro-Chrome (of the usual and lowest carbon contents) and "ELECTROMET BRAND" 50% Ferro-Silicon always in stock in this country for immediate delivery.

#### FERRO TUNGSTEN

70 to 80% Tungsten, Maximum 0.50% Carbon.

#### FERRO MOLYBDENUM

70 to 80% Molybdenum, Maximum 0.50% Carbon.

**E. J. LAVINO & CO., BULLITT BLDG., PHILADELPHIA, PA.**

Sales Agents for the U. S. and Europe for the Products of the  
**ELECTRO METALLURGICAL SALES CORPORATION, NEW YORK AND PHILADELPHIA**  
WORKS: KANAWHA FALLS, W. VA., AND NIAGARA FALLS, N. Y.

### ORES

Chrome, Manganese, Iron, etc.

#### SPECIALTY:

**"IMPERIAL CHROME ORE"**

The well-known Refractory Ore for Furnace Linings—  
Lumpy, Low in Silica and Low in Iron.

**FLUORSPAR—Lump and Gravel**

# CAUSTIC SODA

## Reason No. 5\* Why Laclede-Christy Chemical Rings and Tile Make Better Acid-Proof Packing for Towers

The importance of tower packing being acid- and alkali-proof to the nth degree, cannot be over-emphasized. All packing for towers is capable of resisting the action of acids and alkalis to some extent, the exact extent determining good packing from poor.

Laclede-Christy Tower Packing not only resists acids and alkalis, but is actually proof against their action. We back our claims with the results of the following tests, in which pieces of Chemical Tile were treated with Caustic Soda (Sodium Hydroxide) solutions 144 hours, one half of this time being held at boiling temperatures:

No. 1—75% Caustic Soda.  
25% Water.  
Loss in weight—.0006053%—only 6/100 of 1%.

No. 2—50% Caustic Soda.  
50% Water.  
Loss in weight—.0006031%—only 6/100 of 1%.

No. 3—25% Caustic Soda.  
75% Water.  
Loss in weight—.000491%—only 4/100 of 1%.

NOW, won't you use Laclede-Christy Chemical Rings or Tile in your towers? Write for our quotations.

We manufacture four styles of acid-proof packing—chemical rings, triangular brick, square brick and "A" Tile. We also specialize in the manufacture of odd shapes.

## LACLEDE-CHRISTY CLAY PRODUCTS CO.

Manchester and Sulphur Aves., St. Louis, Mo.

\*Reason No. 1—Large contact surface.  
Reason No. 2—Less than 1% absorption.  
Reason No. 3—Negligible loss in weight when tested with Sulphuric Acid.  
Reason No. 4—Negligible loss in weight when tested with Nitric Acid.

## Milton Brick Company

Plant: Milton, Pa. New York Office: 47 W. 34th St.

### SPECIALISTS IN "Acid Proof" Shale Brick

Used by the U. S. Government and leading Chemical Companies, Refiners of Copper, etc.

Write for prices and samples of Milton SPECIAL "Acid Proof" Shale Brick and Milton STANDARD "Acid Proof" Shale Brick.

## SINTERING

FINE ORES AND CONCENTRATES

FOR THE BLAST FURNACE  
IS STANDARD PRACTICE

## Dwight & Lloyd Sintering Co.

INCORPORATED

29 Broadway, New York

CABLE ADDRESS, SINTERER

## Harbison-Walker Refractories Co.

Manufacturers of

High Grade Fire Clay Brick  
Silica Brick Chrome Brick  
Magnesia Brick

Importers of

Chrome Ore & Dead Burned Magnesite

General Offices:

Farmers Bank Building, Pittsburgh, Pa.

## NONPAREIL INSULATING BRICK

For Insulating Furnaces, Ovens, Boiler Settings, Blast Mains, Stoves, Kilns

Efficient, Strong, Easy to Apply

ARMSTRONG CORK & INSULATION CO.

156 Twenty-fourth St., Pittsburgh, Pa.

## FERRO CARBON — TITANIUM

The Final Cleanser and Deoxidizer—For all Steels  
TITANIUM ALLOY MANUFACTURING COMPANY



Operating under Rossi Patents  
Processes and Products Patented  
General Office & Works: Niagara Falls, N. Y.  
Pittsburgh Office: Oliver Building  
Chicago Office: Peoples Gas Building  
New York Office: 165 Broadway

AGENTS:  
Great Britain and Europe: T. Rowlands & Co., Sheffield, Eng.



# MAGNESITE

(Crystalline Product)

AMERICAN  
MINERAL  
PRODUCTION  
COMPANY

**Crude, Calcined and Dead Burned**

Equal to

AUSTRIAN, GRECIAN, ETC.

Any percentage of

**Magnesium Carbonate  
Calcined Magnesium Oxide**

OWNERS  
and  
OPERATORS

LIME, SILICA IRON AND ALUMINA  
CAN BE GUARANTEED

SALES  
DEPARTMENT

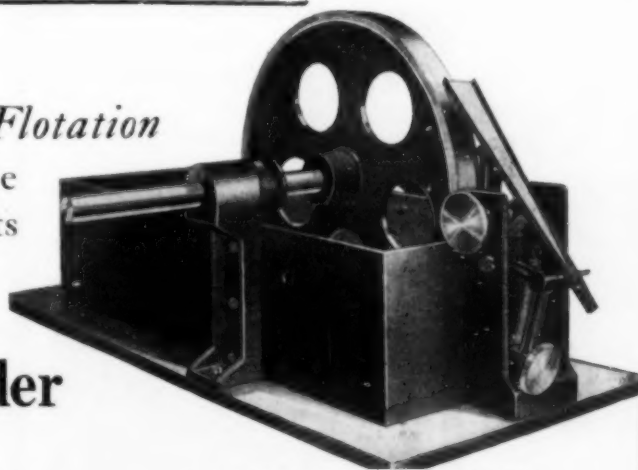
## MAGNESIA MATERIALS

for REFRACTORY, CEMENT, STUCCO, PAPER, TEXTILE and  
CHEMICAL PURPOSES

UNITED STATES United States Magnesite Corporation, 11 Pine St., New York, N. Y.  
H. H. Brunt & Co., 662 Insurance Exchange, Chicago, Ill.  
EUROPE—Brunt & Co., Dickinson St., Manchester, England

The Problem of *Successful Flotation*  
depends to a great extent upon the  
regularity of the flow of reagents

### The Braun K. & K. Mechanical Disc Feeder For Oils and Acids



(Patented Nov. 30, 1915, No. 1162291)

absolutely eliminates detrimental results due to irregularity in feeding reagents.

A Mechanical Disc is mounted on a shaft and revolved within an iron tank. A thin film of oil adheres to the finished surface of the disc as it revolves through the oil, which film is constant, being regulated by an adjustable metallic scraper. A portion of this film is transferred to the trough through which it flows into the flotation machine.

The feed is regulated by adjusting the position of the trough by means of micrometer screws.

Grit, sludge, or any foreign matter cannot choke it.

**BRAUN-KNECHT-HEIMANN-CO.**

**THE  
BRAUN CORPORATION**

San Francisco, U. S. A.

Los Angeles, U. S. A.

Manufacturers of Laboratory Labor-Saving Machinery  
Specialists in Laboratory Equipment and Testing Apparatus  
Dealers in Laboratory Glassware and Chemicals

Two types of machines are offered  
—one for Oil and one for Acid.

The Acid Feeder is constructed of  
lead and bronze to withstand the  
action of the reagents.

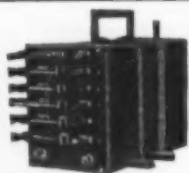
Fitted with tight and loose pulleys  
(not shown in illustration).

Measurements: Length, 30 in.;  
width, 20 in.; height, 15 in.

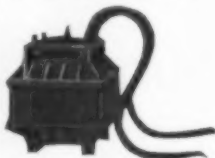
BRAUN K. & K. OIL FEEDER,  
\$40.00.

BRAUN K. & K. ACID FEEDER,  
\$75.00.

Ask for Bulletin A106



Portable  $\frac{1}{2}$  K.V.A. Laboratory Transformer 1 to 64 volts in 1 volt steps



Laboratory Furnace Transformer.

## CUSTOM AMERICAN MADE TRANSFORMERS

### Economy Should Be a Prime Consideration

in the selection of Transformers. It will pay you to adapt them to the work to be performed.

Because American Transformers are constructed for a specified service, they greatly excel commercial types in economy and efficiency. They are widely used for special laboratory applications, in the Cottrell System of Fume Precipitation, and for other Electro-Chemical and Electro-Metallurgical purposes. Consult our Engineering Department.

**AMERICAN TRANSFORMER COMPANY**  
151 Miller Street, Newark, N. J.



Water Cooled Furnace Transformer.



Air Cooled Furnace Transformer.

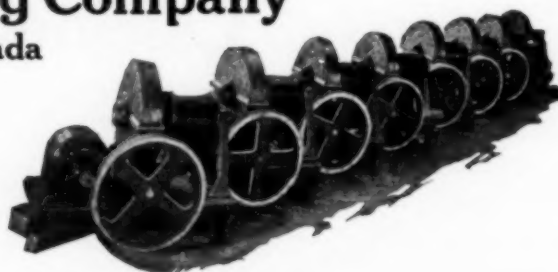
## The Volta Manufacturing Company

Welland, Ontario, Canada

*Manufacturers of*  
Hand and Electrically Operated Winches  
Automatic Regulators  
Electrode Holders  
Electric Furnace Accessories

General Consulting Work  
Machines Designed and Built to Customers' Own  
Special Requirements

Address all inquiries to R. Turnbull, Box 416, Welland, Ontario, Canada



*The*  
**New Herreshoff**  
*Furnace*  
*Patented*  
*for Roasting Ores*

Temperature  
Controlled  
and  
Air-Cooled

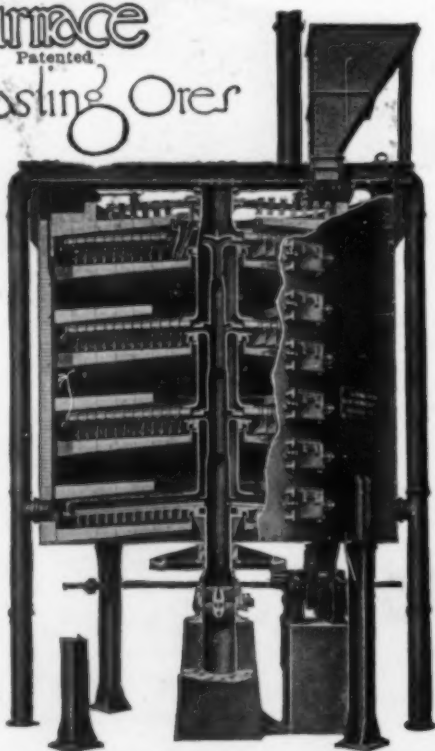
**General  
Chemical  
Company**

Herreshoff  
Furnace  
Department  
New York,  
N. Y.

Pacific Coast  
Agents:

**Pacific  
Foundry  
Company**

18th and  
Harrison Sts.  
San Francisco,  
Cal.



## The Kuhlman Electric Co.

Bay City, Mich.

Designers and Manufacturers of

## TRANSFORMERS

For Electric Furnaces (all sizes) also Lighting and Power

Special Transformers of all kinds

*Send for new bulletins just coming off the press*

(See our regular advertising in The Electrical World)

## SAFETY FIRST!

*Do your furnace men suffer from the heat?*

Use a Wiegand Patent

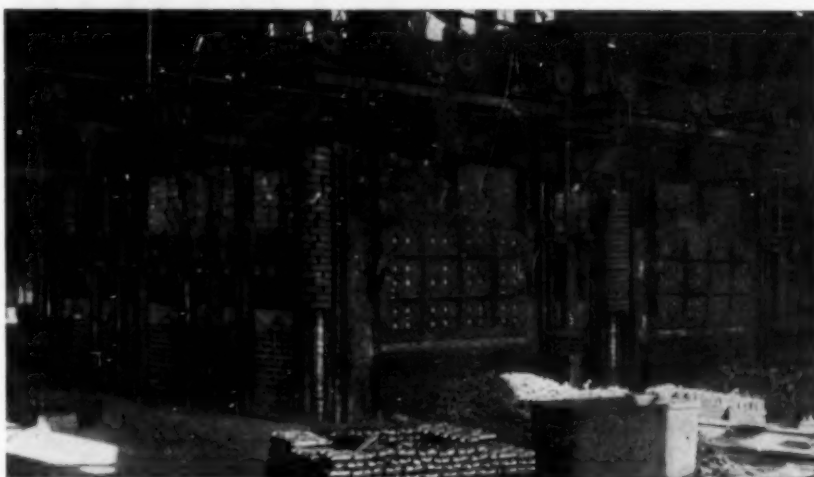
## Chain Screen Door

**E. J. CODD CO., Manufacturers**

700-8 S. Caroline St., Baltimore, Md., U. S. A.

MACHINERY—BOILERS—TANKS

# INDUSTRIAL HEAT OPERATIONS



*Annealing Furnaces, installed at the Plant of the Remington Arms Company, treating 20,000 to 40,000 lbs. of material per charge*

CONSULTING, ENGINEERING, DESIGNING AND CONSTRUCTION WORK  
OF ANY CHARACTER RELATING TO THE APPLICATION OF  
GAS FOR INDUSTRIAL PURPOSES

## THE SURFACE CO. COMBUSTION CO.

LONG ISLAND CITY, N. Y.



### ANNEAL



**AUTOMATICALLY — EFFICIENTLY**

Automatic Annealing is daily producing a better product and larger output than hand-operated methods.

"ROCKWELL" Automatic Annealing Furnaces have proven to hundreds of users their superior efficiency in uniformly heating each piece to an equal temperature for a given length of time. The resulting increased output, with its proportionately decreased fuel and labor costs, greatly reduces production costs.

Many of your Annealing operations will be greatly improved and costs reduced by using "Rockwell" Automatic Annealing Furnaces.

*Send for Catalog No. 30-M on Automatic Furnaces*

**W. S. ROCKWELL COMPANY**

**Furnace Engineers and Contractors**

**50 Church St.**

**New York**

(Hudson Terminal Bldg.)

**BRICK  
BLOCK**



**POWDER  
CEMENT**

**Here Are Five Reasons  
Why You Should  
INSULATE WITH**

**SIL-O-CEL**  
TRADE MARK  
MADE FROM GELITE

The proper insulation of heated equipment with SIL-O-CEL will result in

1. Increased capacity.
2. Greater uniformity and better distribution of heat throughout equipment.
3. Saving in fuel by confining heat to most effective zone.
4. Better control of temperatures, preventing damage to equipment through localized over-heating.
5. Improved working conditions about the heated equipment.

*Send coupon to nearest office for samples and detailed information*

**CELITE PRODUCTS COMPANY**

NEW YORK: 11 Broadway  
PITTSBURGH: Oliver Bldg.  
CHICAGO: Monadnock Bldg.  
LOS ANGELES:  
Van Nuys Bldg.  
SAN FRANCISCO:  
Monadnock Bldg.

CELITE PRODUCTS CO.

Please send samples and book to

Name .....

Business .....

Address .....

M.C. 39



## Why are 85% of all Stoker Fired Metallurgical Furnaces of Hagan design?



Because of guarantees like the following, covering the

### Hagan American New Model Underfeed Stoker

Fuel saving over hand firing—15 per cent to 50 per cent.  
 Saving over cost of producer gas—30 per cent.  
 Heat units from each ton equal to from 23,000 to 25,000 cubic feet natural gas.  
 Heat units from 12 to 14 pounds common slack coal, equal to one gallon fuel oil.  
 Upkeep cost, including power and labor, will not exceed 17 cents per ton of coal consumed.  
 Make no payments until the above guarantees are fulfilled.

**GEO. J. HAGAN CO.**  
 Peoples Bank Bldg. Pittsburgh, Pa.

## CARBON?

### We Make It

Here are but a few of the applications of manufactured carbon:

For Electrolytic Cells and Electric Furnaces—Carbon electrodes.

For Motors and Generators—Carbon and metal composition brushes.

For Electric Welding—Carbon points.

For Resistance Elements—Carbon.

We can supply anything in the carbon line. Write us.

### National Carbon Co., Inc.

Cleveland, Ohio

### C. W. LEAVITT & CO.

32 Church St., New York

Agents for

### Girod Electric Furnace

and

### Ferro Alloys

### HENRY VOGT MACHINE CO.

Manufacturers of

Ice and Refrigerating Machinery

Water Tube Boilers

Drop Forged Valves and Fittings

"Sectional" Rocking and

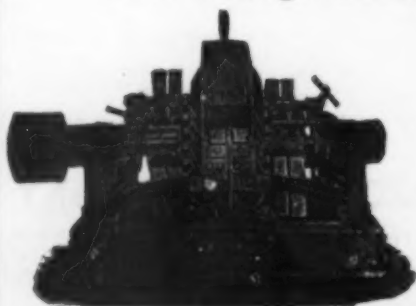
Dumping Grates

"Sectional" Steel Casings

for Boilers

LOUISVILLE, KY.

### Low Voltage Generators



Up to 10,000 amperes

Single, two and three voltages for School and Laboratory work. Deposition, Refining and Separation of metals.

**CHAS. J. BOGUE ELECTRIC CO.**  
 513-515 West 29th St., New York

### Thordarson Transformers

Specially designed and built for your needs. We specialize in transformers for Cottrell Process, Electric Furnaces, Laboratories, etc.

Thordarson Electric Mfg. Co.  
 Chicago, Ill.

### RUSSELL ENGINEERING CO.

High Temperature Furnace Work

Consulting, Designing, Construction, Special Industrial Furnaces, Chemical Reaction Furnaces, Oil Burning Furnaces, Muffles, etc.

International Life Building, St. Louis, Mo.

## VULCAN KILNS



in the designing and making require mechanical judgment.

Not only the general plan, but every detail calls for specially trained engineers, whose work is of such moment that it has grown to be virtually a profession in itself.

Four especially important details, which affect the operation and maintenance of nodulizing or other rotary kilns, are

Gears  
Cradle  
Expansion carriage  
Reinforcing



An evidence of the success with which Vulcan Kilns have solved these problems, is the fact that 65% of all rotary kilns in this country are Vulcans.

### VULCAN IRON WORKS

1742 Main St.  
Wilkes-Barre, Pa.

New York

Chicago



120' x 11'  
Vulcan Rotary Cement Kiln

For bonding and repairing fire clay or silica brick work, tile, retorts, crucibles, etc.

## USE HYTEMPITE THE

(Reg. U. S. Pat. Off.)

High Temperature Fire Brick Cement.

**Quigley Furnace Specialties Co.**

26 Cortlandt Street

New York

## JANTZ & LEIST

LOW VOLTAGE MOTOR GENERATORS

Uniform E. M. F.—150 to 8,000 Amperes  
For Electrolytic Work, Electroplating, Etc.

CINCINNATI, OHIO

## RENNERFELT ELECTRIC ARC FURNACE



Operates on a new principle. Arc acts on the bath in a large flame. Widely used for making steel, ferro-tungsten, melting brass, copper, nickel and ferro-manganese. Seventeen sizes, from 1/2 ton up.

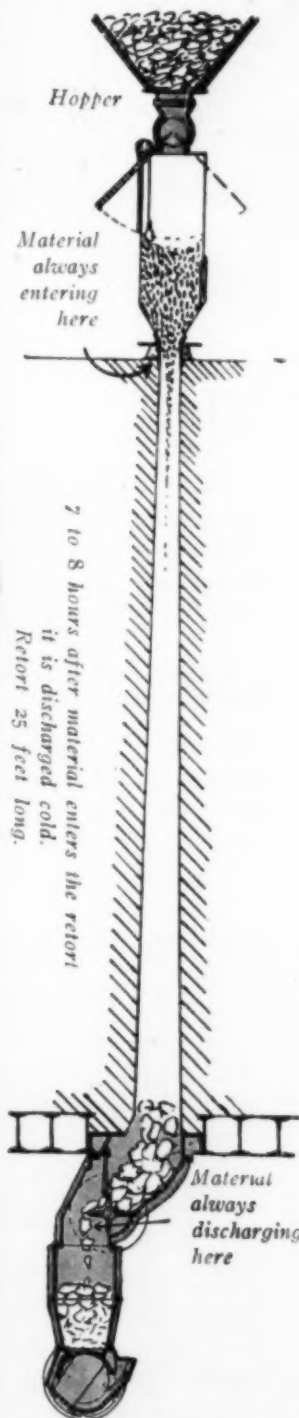
**HAMILTON & HANSELL, 17 Battery Place, New York**  
**Chicago Office, Glen B. Hastings, 1511 Lytton Bldg.**

Woods, Huddart & Gunn, 444 Market Street, San Francisco, Cal.  
W. Montellus Price Co., 224 First Ave., S., Seattle.  
Hyde & Sons, Ltd., New Berks Bldg., Montreal, Canada.

Address Foreign Inquiries to A. B. ELEKTRISKA UGNAR, Stockholm, Sweden.

## Woodall-Duckham Continuous System

of  
Vertical  
Ovens  
for  
Calcination  
of  
Materials



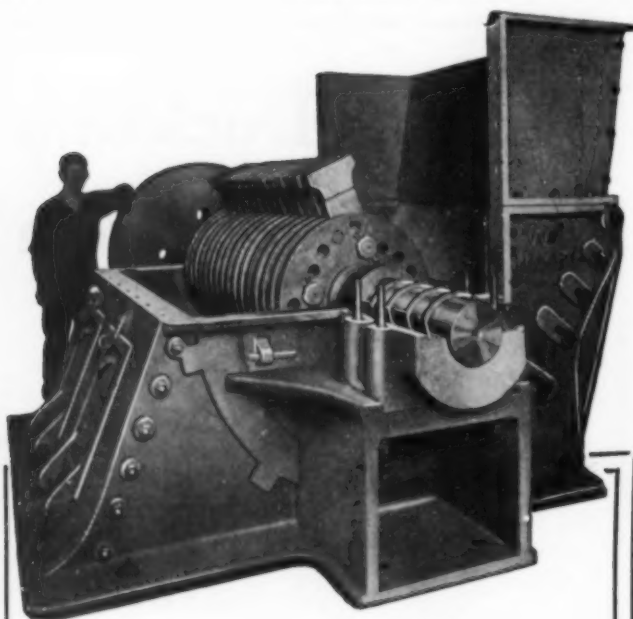
Ovens heated by gases generated by calcining. Material discharged below the ignition point. Waste heat in material and gases utilized to generate steam.

**ISELL-PORTER Co.**

Main Office and Works:  
Bridge and Ogden Streets  
NEWARK, N. J.

Business Established 1865





## ADAPTABILITY

Whether for crushing, grinding, or shredding; whether you wish to handle soft or hard material; whether a fineness of 100 mesh or a product 2" and under is desired; or a capacity of 100 lbs. or 300 tons per hour—

## WILLIAMS

is able to meet your requirements. Williams crushers, grinders and shredders are the most versatile machines manufactured and are adaptable to nearly all materials which it is necessary to reduce—over 600 in number. We have subdivided the various materials into eight divisions as per tables below. Please specify catalog desired by number.

NO. 18	NO. 18-A	NO. 18-B	NO. 18-C
Limestone Lime Gypsum Coal Ochres Dry Colors	Shale Clay Asphalt Sand All Clay Material	Tankage Bone Shells Poultry Food and all Fertilizer Material	Oil Cake Linseed Cotton Seed Castor, Nitro Salt Cake Soy Bean Copra, Etc.
NO. 18-D	NO. 18-E	NO. 18-F	SPECIAL
Stock Food Cereals Alfalfa and all By-Products from Flour Mills	Coal Crushers for Coke Ovens Gas Plants and all Industrial Plants	Shredders Bark, Chips Wood Pulp Licorice Root and all Fibrous Material	Soap Powder All Drug Material Paper Stock and all Chemicals

### THE WILLIAMS PATENT CRUSHER & PULVERIZER COMPANY

GEN. SALES DEPT., OLD COLONY BLDG.

CHICAGO

Plant:  
ST. LOUIS

268 Market St.,  
SAN FRANCISCO



## MEAD MILLS FOR SERVICE

### What do You Grind?

Here are a few of the things that Mead Mills grind with great economy and satisfaction.

Asbestos	Glue
Crude Drugs	Magnesia
Clay	Paint Ingredients
Chalk	Pitch
Chicle	Resin
Carbon	Sugar
Dry Colors	Talc, etc.

The ultimate in design and construction. High speed disc. Regulation as to degree of fineness. Send for catalogue on uses and users.

**MEAD & COMPANY**  
Detroit Michigan — U.S.A.

## GRINDING MILLS



Improved Lead and Paste Mill

Disintegrators, Dryers  
Chasers and Machines for

### LABORATORY & FACTORY

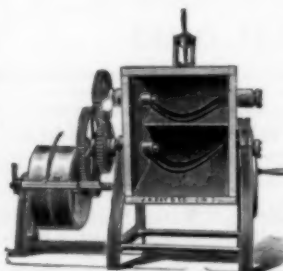
Plans and Estimates for

**SPECIAL MACHINERY**  
Promptly Furnished

### THE J. H. DAY CO.

Office and Factory: Cincinnati, O.

Write for Catalog  
showing complete  
line of Mills and



Giant Kneading and Mixing Machine

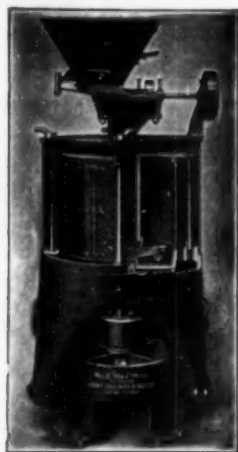
## MIXING MACHINES



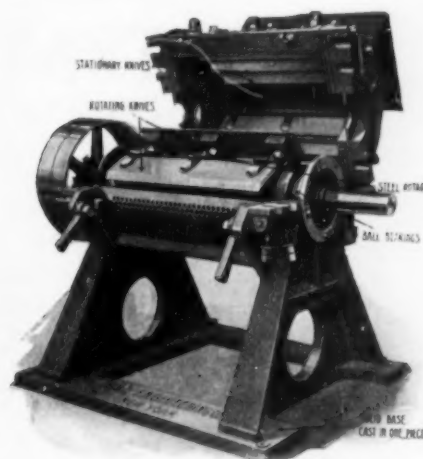


Abbé  
Combination  
Laboratory  
Mill

*No charge for grinding,  
crushing, cutting or mixing  
samples and submitting full  
reports.*



Abbé "Max" Mill  
(Improved) Patented



Abbé Rotary Cutter or Shredder

## A few ABBÉ Products

ABBÉ ENGINEERING CO.  
220 Broadway, New York

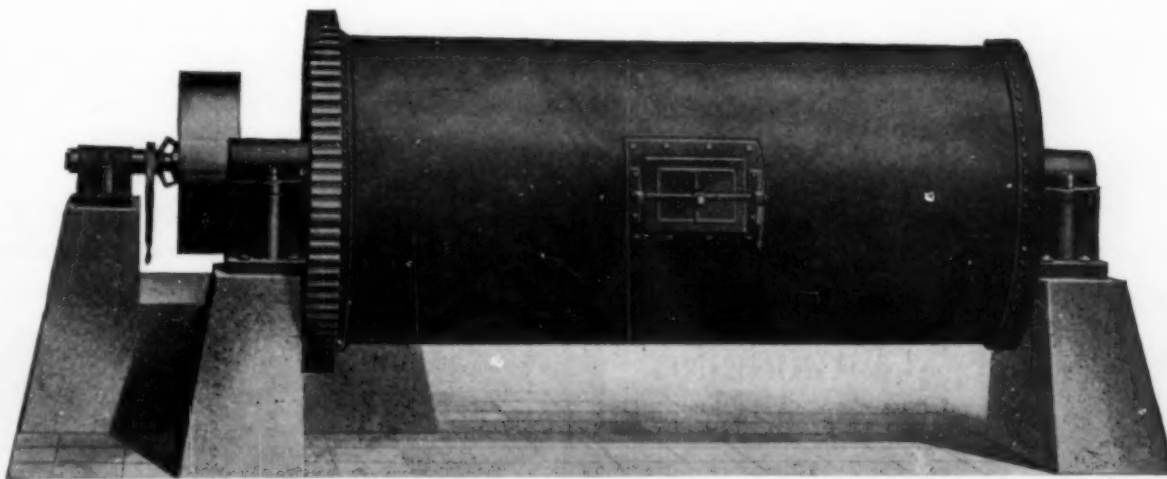
are shown here—just a small part of our patented line of 59 sizes and 20 designs of standard pulverizing machinery or machinery built to order.

Thousands of satisfied Abbé users in the world today testify to the quality of our patented pulverizing machines. Full data upon request.

**ABBÉ ENGINEERING CO.**  
218-220 Broadway, New York

## Patterson Continuous Feed and Discharge Tube Mills

All sizes 4'x10' to 6'x30'. All sizes equipt with Patterson Rapid Discharge Device



**The Patterson Foundry Machine Co.**

Builders of Satisfactory Machines  
East Liverpool, Ohio



## TRAYLOR CRUSHING ROLLS

### Have the "FLEETING ROLL"

Eliminate the personal equation in keeping your roll shells straight and true and free from ruinous corrugations.

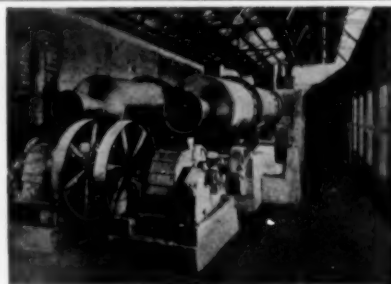
### The Fleeting Roll

is always on the move. It doesn't let the fixed roll stop at any one place long enough to have corrugation get a start, and it's the simplest thing you ever saw.

Six (6) parts that work in oil, that's all.

### Traylor Engineering & Mfg. Co.

Main Office and Works:  
Allentown, Pa., U. S. A.  
New York Office: 28 Church Street  
Chicago Office: 1414 Fisher Bldg.  
Western Office: Salt Lake City, Utah



**"Built  
to Dry  
at the  
Lowest  
Ultimate  
Cost"**

## Ruggles-Coles Dryers

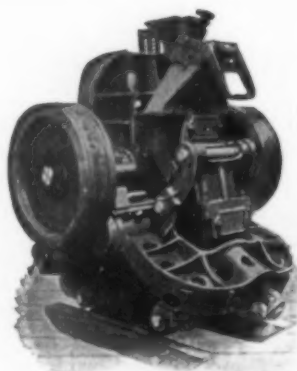
Direct, Indirect or Steam, for every type of service. Over 600 in use have demonstrated their economy and thoroughness.

Ruggles-Coles Dryers insure large production as well as low operating cost.

Department M will acquaint you with full details of these dryers.

### Ruggles- Coles Engineering Co.

Works:  
York, Pa.  
Eastern Office  
50 Church St.  
New York City  
Western Office  
322 S. Michigan  
Ave.  
Chicago, Ill.



Many Metallurgical and Chemical Processes require that the ingredients be pulverized.

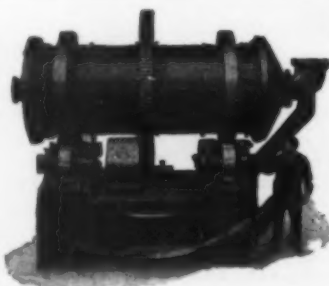
## THE MAXECON MILL

has been perfected to give the greatest output with least power and wear of any pulverizer even on the hardest and toughest materials.

Uniformly satisfactory results are evidenced when companies such as The Aluminum Ore Co., U. S. Steel Corporation, Pennsylvania Salt Mfg. Co., et al., use The Maxecon as their standard grinder.

We will appreciate the opportunity to help solve your grinding problems either on Coal, Bauxite, Limestone, Silica, Clinker, Phosphate Rock, Hard Ores or other materials.

KENT MILL CO., 10 Rapelyea St., Brooklyn, N. Y.



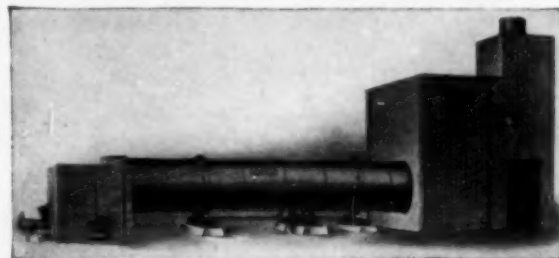
## MARATHON GRINDING MILL

has demonstrated its superiority over the Chilean, Pebble and other mills in an official test.

*Write for a reprint copy of it.*

### Johnson Engineering Works, Chicago First National Bank Building

Pacific Coast Manager, H. L. Van Winkle, 160 Beale St., San Francisco



## THE REDFIELD DIRECT HEAT DRYER

REGULAR AND COUNTER CURRENT TYPES

ROBERT S. REDFIELD

327 So. LA SALLE ST.

CHICAGO

ILLINOIS

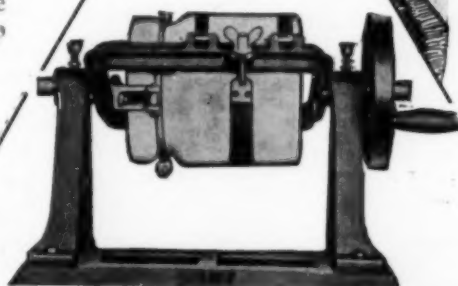
## The V. P. of Disintegrating Troubles

At the far-distant point where the sky joins the "edge of the world," large objects dwindle and vanish into nothingness.

The "vanishing point" of your disintegrating problems, if you have any, will very likely be found by taking the matter up with me personally.

You might as well profit by my successful experience in devising machinery and appliances for improving or perfecting the various processes in which I specialize.

Hundreds of others have done it—why not you?



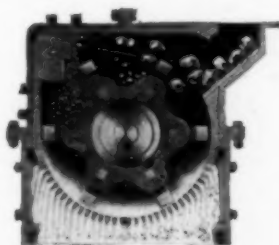
**PAUL O. ABBÉ**

CRUSHING, CUTTING, GRINDING, MIXING,  
PULVERIZING AND SIFTING MACHINERY

JAR MILLS  
PEBBLE MILLS  
(Sometimes called Ball Mills)  
CRUSHERS  
CUTTERS  
CAGE MILLS  
DISINTEGRATORS  
SIFTERS  
MIXERS  
SILEX LINING  
SELECTED FLINT PEBBLES  
PORCELAIN BALLS  
PORCELAIN LINING  
PORCELAIN JARS  
RUBBER GASKETS  
BOLTING CLOTH  
ATTRITION MILLS  
PACKAGE PACKERS  
RESPIRATORS  
HAMMER MILLS

**Dufour Bolting Cloth**

Rooms, 920-924 Johnston Bldg., New York



Illustrating interior of K-B Pulverizer while in operation

### Aside from the SAVING in power costs

which can be demonstrated to your entire satisfaction, the ALL Steel construction of the

## K-B PULVERIZER

insures the permanency of your investment if you equip with this crusher.

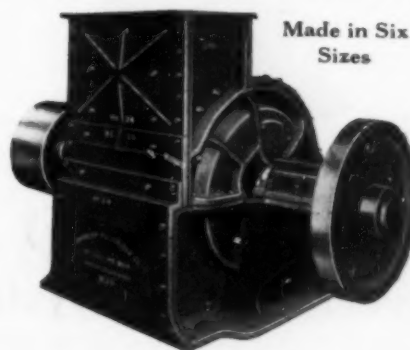
Practically indestructible it never goes to the scrap heap—and the initial cost, which is low, covers about all the outlay necessary.

The K-B will reduce any sort of moderately hard materials from 3" to dust in one operation.

Send for latest Catalog.

**K-B Pulverizer Co., Inc.**  
86 Worth Street, New York

## American Ring Pulverizer



Made in Six  
Sizes

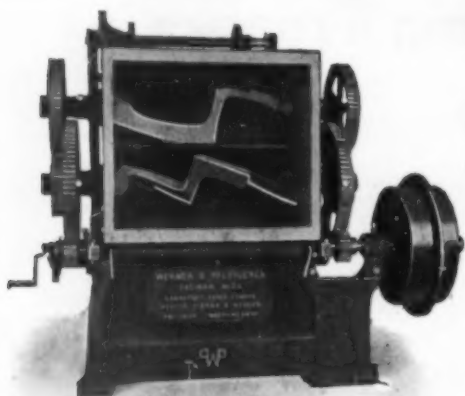
Will Crush and Pulverize

Shale	Limestone	Phosphate Rock
Clay	Gypsum	Ferro Silicon
Kaolin	Quartz	Ferro Manganese
Coke	Ore	Carbon Butts
Coal	Glass	Bone Chemicals.
Chalk	Feldspar	Etc., etc., etc.

The distinctive features that make the AMERICAN superior, and produce greater tonnage at less operating cost, are described in our catalogue—Send for it.

**AMERICAN PULVERIZER CO.**  
EAST SAINT LOUIS ILLINOIS





## Werner & Pfleiderer Advisory Service Successfully Solves the Biggest Mixing Problems.

There's no problem too complex for the WERNER & PFLEIDERER COMPANY ADVISORY SERVICE DEPARTMENT. Time after time, in the long history of this concern, our service department has solved problems that had seemed beyond solution.

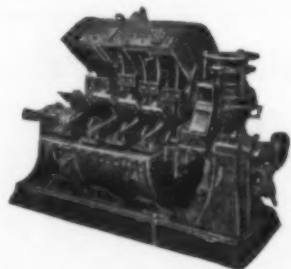
Have you any puzzles in mixing or kneading different materials at different temperatures? Call upon us for help. We may be able to lend you valuable assistance.

W & P apparatus is found wherever efficient mixing and kneading processes are carried on—in chemical work, manufacture of paints, colors, explosives, varnishes, cellulose, putty, rubber, cements, and so on.

We also make, in addition to mixing and kneading machines, such machinery as high power screw presses with variable speeds, rapid dissolvers, automatic weighing scales, and rubber machinery.

WERNER & PFLEIDERER service is backed up by an extensive research and laboratory department. It has saved thousands of dollars for others, in all parts of the world. It may save money for you.

**WERNER & PFLEIDERER COMPANY**  
 Emil Staehle General Manager  
 Saginaw, Michigan, U.S.A.  
 New York Philadelphia Cleveland San Francisco  
 3701 Woolworth Bldg. 665 Drexel Bldg. 508 Hippodrome Bldg. 364 Pacific Bldg.



## THE AERO Pulverized Coal System

is a *Unit System*. The Pulverizer and the furnace is the unit. There is nothing between them but a plain iron pipe.

The AERO is a no-storage system and therefore free from fire and explosion hazards. Coal drying is optional.

The pulverizing, mixing and feeding operation, as well as the furnace, are at one time under the eye of one man.

Write for Bulletin.

**AERO PULVERIZER CO.**  
 Equitable Bldg., New York

**The Morgan Producer Gas Machine**  
 is the highest class gas producer built in the U. S. and is advertised in the 1st of the month issues of this journal.

**Morgan Construction Co.**  
 Worcester, Mass.

### CHAPMAN GAS PRODUCERS

are the simplest, least expensive, and most satisfactory producers for furnace work. Built in Mechanical and Semi-mechanical Types.

Write us your requirements, and we will be glad to recommend the type and size best suited to your conditions.

**Chapman Engineering Company, Mt. Vernon, Ohio**

### SMITH SECTIONAL GAS PRODUCERS

Clean cold producer gas in unlimited quantities

High in quality and uniform in heating value.

The Smith System produces a tar-free gas—a clean fuel for particular manufacturing processes.

**THE SMITH GAS ENGINEERING CO., Lexington, O.**

### Copperas

We are producers of green crystal Copperas (ferrous sulphate). Correspondence invited from consumers and jobbers of this commodity. Address

**N. & G. TAYLOR COMPANY**  
 300 Chestnut Street Philadelphia, Pa.

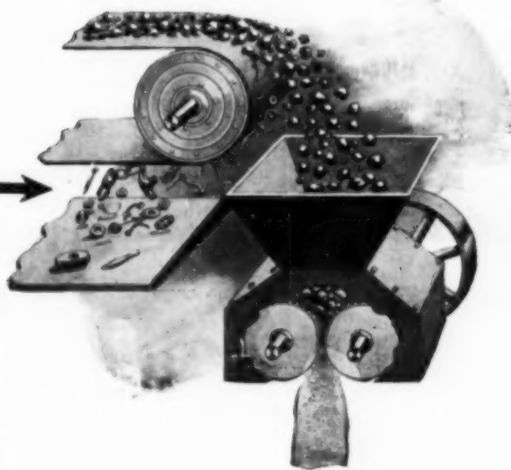
The iron goes UNDER

The ore goes over

## DINGS Magnetic Pulleys

Save  
tie-ups

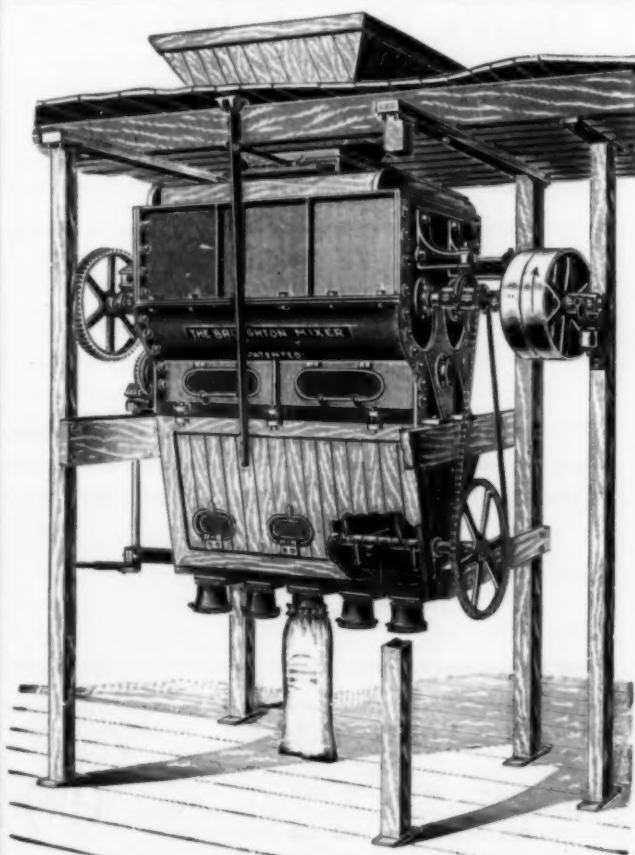
Prevent  
smashed crushers



Feed tramp iron between the crusher rolls—something has got to give. It may or may not be the scrap—iron can't be crushed. More than likely it will mean another crusher incapacitated—choked—smashed. You know what that means in delayed operation and direct repair expense.

The DINGS Magnetic Pulley removes scrap iron and all magnetic material from the softer ore. It simply replaces the head pulley of the belt conveyor, and is therefore easy to install. For smelters and refiners, zinc, lead and tin mines, etc. Let us co-operate with you to safeguard your crushers against abuse.

Dings Magnetic Separator Co., 673 Smith St., Milwaukee, Wis.



## Rapid Incorporation of Dry Materials

depends upon unusual thoroughness of the mixing mechanism and unfailing reliability of the various units which make up the machine.

## The Broughton Mixer

has a peculiar arrangement of blades which results in quicker and better mixing. It is continuous in operation—the product is bagged and hopper filled while a charge is being incorporated.



Big Results from a  
little coupon.  
Send it.

**W. D.  
Dunning**  
Syracuse,  
New York

W. D. Dunning, Syracuse, N. Y.  
Please send it free—your book  
on "Better Mixing."

Name.....

Address.....

**"There are two jobs waiting for every man there is to take hold"—L. A. Vanderlip, President, National City Bank of New York**

"S-A" Unit Carriers  
can be furnished with Ball  
or Hyatt Roller Bearings.



Style No. 71

### "S-A" Service

is a real institution and not just something we talk about in our advertising. Our machinery in all cases must be designed to meet special conditions, by men familiar with this class of work—that is, by experienced conveying engineers. When one of these engineers designs a plant or conveyor meeting certain requirements, he can usually tell quite clearly how the installation will pay for itself, what its advantages are, and what it will cost. Beyond that, the proposition is one for the customer only to decide.

The demand for labor has been great enough in the past few years to suit most people.

But now it is to become even greater and the supply is going to decrease—wages must continue on the upward trend.

The substitution of mechanical methods for the hand operations of the past are an absolute necessity.

One of the most prolific causes for high production costs—one of the greatest sources for waste—is in the handling and conveying of materials and products. It is in this field that often the greatest immediate saving can be effected.

## "S-A" Conveying Engineers

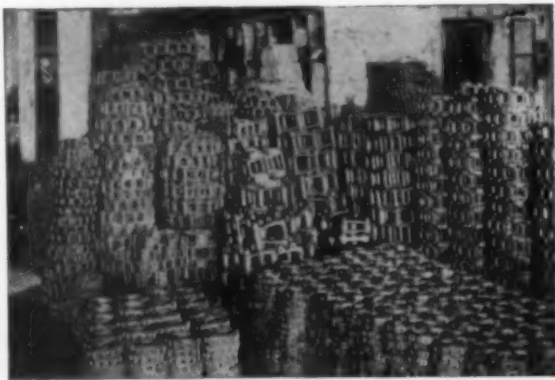
have solved many of the most difficult problems in this class of work. They have designed and installed many of the most efficient plants in the country. This cumulative experience and the resulting perfected machinery is at your disposal to prepare your plant to meet these extreme business conditions.

"The Labor Saver," which is published occasionally to keep you informed of the latest developments in the conveying field, will also show you the class of work in which S-A Engineers are engaged. It will enable you to decide whether or not they can help you with your problem. Let us put you on our mailing list—gratis—today.

**Stephens-Adamson Mfg. Co.**

Aurora, Ill.

## A CHAIN



for

### Every Elevating and Conveying Service

From the lightest detachable type in malleable iron to heavy steel chains for steel mills.

Every foot tested to proof load before shipment.

Tell us your needs and we will tell you of a chain suited to your case.

**The Webster M'f'g Company**

(173) Chicago Tiffin, Ohio New York

## Heavy Plate Fabrication

Dryers, Digesters, Cookers, Chemical Tanks, Welded Vessels, Galvanizing Kettles, Autoclaves, Mixers, Incinerators, Retorts, etc.

**Manitowoc Engineering Works**

MANITOWOC,

WISCONSIN

## ROBINS CONVEYING MACHINERY

Our bulletin describes the successful solution of many materials-handling problems. Let them help you.

### ROBINS CONVEYING BELT COMPANY

New York, 22 Park Row

Chicago, Old Colony Building

Salt Lake City, Newhouse Building

San Francisco, The Griffin Co. Toronto, Gutta Percha & Rubber, Ltd.

London, E. C., Fraser & Chalmers, Ltd.

## LINK-BELT LABOR SAVING MACHINERY

Built to suit individual requirements.

Write for General Catalog No. 110.

Locomotive Cranes, Coal and Ashes Handling Machinery, Elevators and Conveyors, Silent Chain Drives, etc., etc.

### LINK-BELT COMPANY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

Branch Offices Everywhere

## Asbestos Protected Metal Roofing and Siding

For permanent industrial buildings of all classes. Economical—Low maintenance. Permanent without paint under the most severe conditions of service. Ask for Bulletin 5515.



**Asbestos Protected Metal Co.** First National Bank Building Pittsburgh



## Lead Burning—a Nation-wide Service to those seeking Quality

This Organization is well directed and financed, and specializes in Lead Burning on a contract basis anywhere in the United States and Canada.

No order is too large or too small.

Our equipment is our own—and our expert men are retained by us;

not simply hired for the particular work in hand.

We will guarantee our work for Quality—and for Completion within (or before the expiration of) contract time.

From men seeking Quality rather than Cheapness in price, we solicit inquiries.

### MOORE & SIMONSON

LEAD BURNING CONTRACTORS

339 Hudson Terminal Bldg., 30 Church St., New York City

Phone 1053 Cortlandt

Brooklyn Office  
133 Halsey St.  
Phone 5693 Bedford

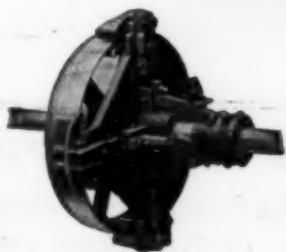
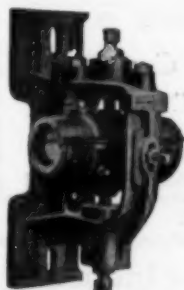
Shop:  
Linden, N. J.

Canadian Representative  
H. K. Gray  
Traders Bank Bldg., Toronto

### USE CALDWELL POWER TRANSMITTING MACHINERY

Designed by experienced engineers, heavy construction for EFFICIENT SERVICE

Gears  
Pulleys  
Flywheels  
Rope Sheaves



Friction Clutch Couplings  
Friction Clutch Pulleys  
Shafting, Bearings  
Chain and Sprockets

Catalog shows the complete line, also our ELEVATING and CONVEYING MACHINERY.

**H. W. CALDWELL & SON CO.**

CHICAGO: 17th St. and Western Ave.

DALLAS, TEXAS: 711 Main Street

NEW YORK: 50 Church St.



### Pittsburgh Foundries Cuts Plant Haulage—

The Pittsburgh Iron & Steel Foundries Co., of Pittsburgh, Pa., speeds up production and cuts down manufacturing costs with a "Plymouth" Friction-Drive Gasoline Locomotive which runs in and out of the buildings, delivering raw material and finished product, switching freight cars, and, generally, making itself useful.

#### The Plymouth Friction-Drive Gasoline Locomotive Cuts Haulage Costs One Half

It costs one-third to one-half less to buy, install and operate than ANY other system—power or horses—because the inexpensive "Plymouth" Friction Transmission replaces the costly gear transmission, cuts down on fuel and lubricants, and gives greater power.

#### These Plants Prove Our Claims

Among the several hundred industrial plants using one or more "Plymouth" Locomotives in yard and plant haulage are:

Grasselli Chem. Co. John Lucas & Co.  
Nixon Nitration Wks. Nat. Synthetic Co.  
Hercules Powder Co. Bethlehem Stl. Co.  
Duquesne Steel Co. Amer. Gypsum Co.

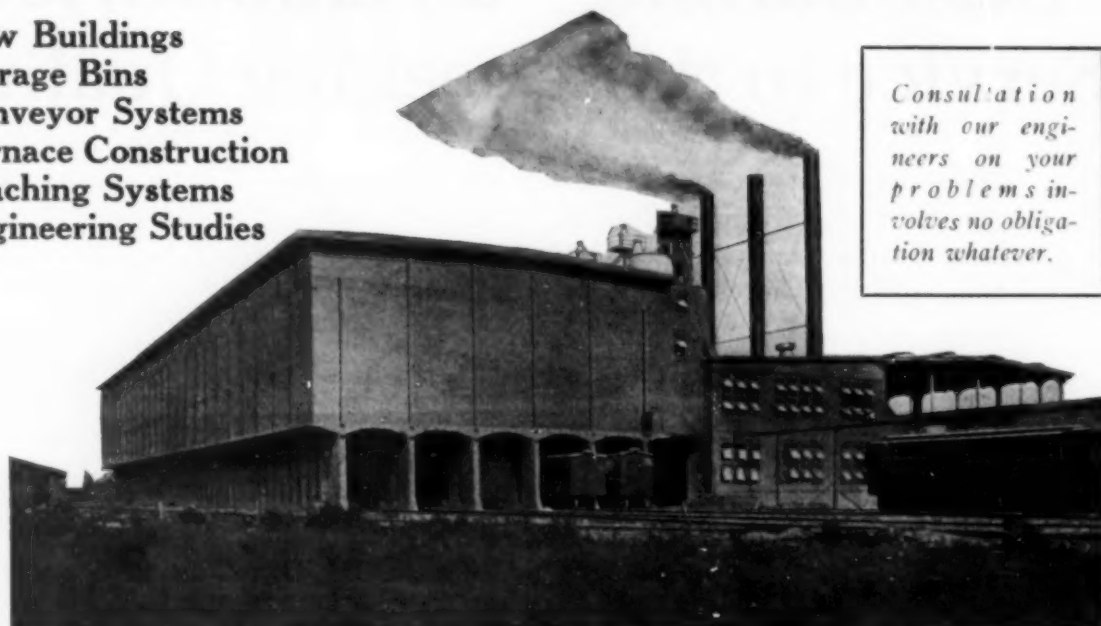
"Cutting Haulage Costs in Two," is a big little book telling of some thirty or more installations. It has cost data, and lots of other valuable information. A copy for the asking.

**THE J. D. FATE CO.,**

214 RIGGS AVENUE  
Plymouth, O.

# CHEMICAL PLANTS

New Buildings  
Storage Bins  
Conveyor Systems  
Furnace Construction  
Leaching Systems  
Engineering Studies

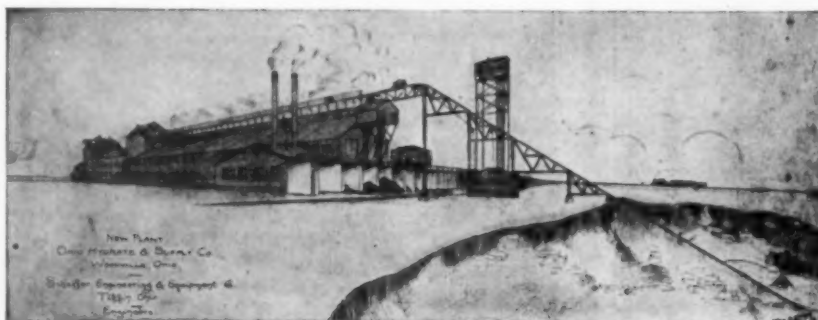


*Consultation  
with our engi-  
neers on your  
problems in-  
volves no obliga-  
tion whatever.*

## GUARANTEE CONSTRUCTION COMPANY

Chicago Office: 108 So. La Salle Street

150 Cedar Street, New York



### One of the Schaffer Engineering & Equipment Company's Plants

(Now being constructed)

We are specialists in the design and construction of heavy duty automatic plants for the Cement, Fertilizer, Lime Industries, etc.



The Schaffer  
Engineering &  
Equipment Co.  
Tiffin, Ohio

**ELMORE**

### ACID RESISTING CENTRIFUGAL PUMPS

VOLUTE CUT OUT OF SOLID WOOD  
Bronze Parts, Outlast Several Solid Bronze Pumps—  
Sizes to 12 in.

G. H. ELMORE, Engineer, PHILADELPHIA—SCRANTON

### The Sharples Specialty Company CENTRIFUGAL ENGINEERS

Westchester, Pa.

### THE IMPROVED EQUIPMENT CO.

80 Wall Street, New York City

#### COMBUSTION ENGINEERS

DESIGNERS AND BUILDERS OF

COMPLETE GAS PLANTS      GAS BENCHES  
LINE BURNING PLANTS      GAS PRODUCERS  
SPECIAL INDUSTRIAL FURNACES

DESIGN  
CONSTRUCTION  
ERECTION

### Chemical and Industrial Equipment

Rapid Delivery — Fine Workmanship

Henry E. Jacoby  
Contracting Engineer

95-97 Liberty St., New York

## We are Engineers for the design and erection of Acid Towers, Acid Tanks or complete chemical Plants ready to operate

Our line of standard apparatus includes the CHEMICO CONCENTRATOR (patented), which produces 98% white concentrated Sulphuric Acid by an entirely new process as applied to this acid. Cost of production greatly lessened.

Waste Gas and Waste Acid Recovery Plants built for reliable concerns, to be paid for out of the profits from the plant's operation.

### "Acipruf"

the cement for binding together acid-proof brick, is used exclusively by us in place of perishable metal linings. It is not simply acid-resisting—it is proof against all acids, hardening and binding better with continued use.

## CHEMICAL CONSTRUCTION COMPANY

LOOK BOX 173 CHARLOTTE, N. C.

Our Agents for Europe and the British Colonies (except Canada) are

Messrs. Huntington-Heberlein Co., Ltd.,  
7 Gracechurch St., London, E. C., England.

## Mechanical Apparatus for the Manufacture of Benzol, Toluol Aniline Dye Products Picric Acid Acid Resisting Castings

Long experience in chemical work enables the selection of Cast Iron best fitted for any specified service.

**Samuel L. Moore & Sons Corporation**  
Elizabeth, N. J.

# KALBERRY CORPORATION *Service*

*strictly  
as Consulting Engineers*

## to become part of Your Organization

Service, somebody has remarked, is an over-worked word and an underworked idea.

We use this word SERVICE in a certain definite sense—*Consulting Engineering Service* of the most complete kind.

For example, we will work out "flow sheets," furnish a client with complete detail drawings, bills of material, specifications for all work and materials to be purchased, and other information required for building. We will "house break" the plant with our own operatives and exercise supervisory inspection when desired.

### We Design

Plants for Chemical and Industrial manufacture, and especially for Sulphuric, Muriatic, Nitric and Acetic Acids; Chemical Salts, Lithophone, Blanc Fixe and White Lead.

Treatment of Zinciferous and other Sulphide Ores and the recovery of their metallic and acid contents.

Prevention or elimination of Dust, Fume and Odor.

Complete designs and license for the

### Kalberrry Tower Concentrator

For the concentration of Sulphuric Acid to any strength up to 97%, and for other liquids and chemical solutions. In successful use for twelve years and adopted in many plants throughout the country.

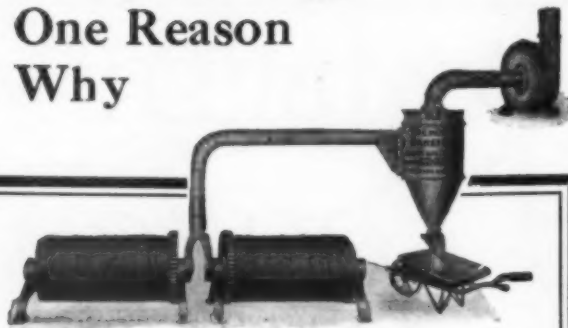
## THE KALBERRY CORPORATION

*Investigation—Research  
Design—Operation*

31 UNION SQUARE WEST  
NEW YORK, N. Y.



## One Reason Why



## The MORSE RAREFIED Dust Collector is Economical

Notice that the dust, sand and other impurities *do not* pass through the fan.

This feature keeps the bearings of the fan free from the abrasive substances that shorten its life—that cause breakdowns.

There are no moving parts in the Morse Collector. Nothing to wear out and replace.

It has no dust cloths to fill up, wear out and renew.

The collected materials are discharged automatically.

The suction is constant.

These points are the ones which are a great source of annoyance and expense in many dust collectors. They are the deciding factors in the economical operation of a dust collector.

They are important enough to warrant your investigation.



Here is  
the  
Story



Send for  
the two Booklets

## The Knickerbocker Co.

521 Liberty Street

Jackson, Michigan

## Hermansen's Improved Dust Collector

For Vent pipes from Raymond Mills, Cyclone Collectors or any vent pipes carrying dust-laden gases.

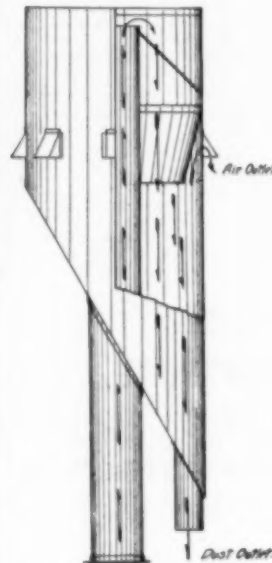
Relieves your conveyor lines,

**Keeps the Plant  
Clean and Saves  
the Dust**

Fully guaranteed and protected by U. S. and Foreign patents. Write for prices and booklets.

Manufactured by

**The York  
Corrugating  
Company**  
York, Pa.



## Tell Us Your Dust Troubles

Automatic Recovery of Valuable Solids or Dust from Gases at any Temperature.

We solve any Dust Problem on any kind of Dust—under any circumstances and conditions.

Our Specialties—Combined Dry and Wet Centrifugal Systems on Kilns—Dryers—Ore Roasters and Furnaces—Cloth Filter Machines—Turbo Gas Washers.

**The Clark Dust Collecting Co.**  
Fisher Building Chicago, Ill.  
DUST COLLECTING ENGINEERS

## Prompt Shipment of Fans and Blowers.

That is one of the things we pride ourselves on  
This is the plant that makes it possible



**LARAGE FAN COMPANY**

HEATING, VENTILATING & DRYING ENGINEERS.

KALAMAZOO—MICHIGAN—U. S. A.  
NEW YORK — CLEVELAND — CHICAGO

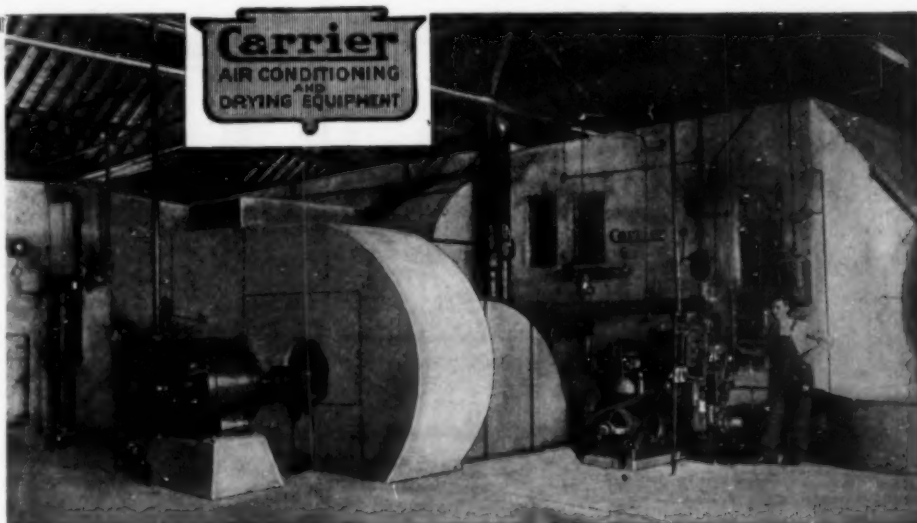
See our Full Page Advertisement in May 1, 1917, issue.

They all use

## CARRIER SYSTEMS

Thomas A. Edison, Inc.  
Bethlehem Steel Co.  
American Can Co.  
Armour & Co.  
U. S. Government Arsenal  
General Electric Co.  
Corticelli Silk Co.  
Vitagraph Co.  
Procter & Gamble  
American Tobacco Co.  
Bankers Trust Co.  
Winchester Repeating Arms Co.  
J. P. Morgan Co.  
Curtis Publishing Co.  
American Thread Co.  
American Locomotive Co.  
American Druggist Syndicate  
Ford Motor Co.

This list of well known names is representative of many hundred others who have endorsed the CARRIER SYSTEM by using it.



## CARRIER AIR CONDITIONING AND DRYING EQUIPMENTS

In the making of such diversified products as rubber, tin cans, macaroni, citric acid, time fuses, electric lights, motor cars, pottery—in silk spinning, paper making, color printing, munition work and drug manufacture, CARRIER SYSTEMS have in numerous instances kept plants running at full capacity and delivering normal output under extreme

and variable weather conditions which forced temporary shutdown of non-equipped plants in the same lines.

Just what a CARRIER SYSTEM will do for you under any given conditions is a matter on which our free advice and cost data should be helpful. Our Bulletin will be sent anywhere on request.

## Carrier Engineering Corporation

39 Cortlandt St., New York

Chicago:  
Transportation Bldg.

Boston:  
176 Federal St.

Buffalo:  
Mutual Life Bldg.

Philadelphia:  
Land Title Bldg.

## WEBSTER

### Air Conditioning Apparatus

for Air Washing,  
Humidifying, Dehumidifying,  
Cooling, Drying,  
Reclamation of Materials,  
Dust Removal

### The Braemer System of Humidity and Temperature Control

The conditioning of air in chemical and other industrial plants to improve quality of product, for economy in operations, or to make rate and quality of production independent of weather, involves highly specialized problems.

The wide practical training of our engineers enables us to guarantee definite results in this work and suggest exactly the right type of apparatus.

Tell us your requirements.

### Braemer Air Conditioning Corporation



Manufacturers of equipment for maintaining artificial atmospheric conditions in industrial plants.

[Lafayette Bldg., PHILADELPHIA

New York, Chicago, Cleveland, Cincinnati, Indianapolis, St. Louis, Kansas City



## SPRACO PRODUCTS

SPRAY COOLING EQUIPMENT  
AIR WASHING & COOLING  
PAINT SPRAYING EQUIPMENT

## "Spraco"

—the Spray Nozzle that works revolutionary results

The above Bulletin No. 510, only recently issued, shows the Chemical Industries the uses of Spraco Nozzles which have been developed so far. Many more remain to be demonstrated. Send for a copy.

## Spray Engineering Co.

Engineers—Manufacturers  
Boston, Mass.





### THE LABORATORY DE LUXE!

"THAT is what I call my laboratory, and I think it deserves the name. Did you ever see a cleaner, brighter room? Did you ever see such a fine, even white on walls, ceilings and benches? That white coating is permanent, too. It is

**R.I.W. HOSPITAL & LABORATORY ENAMEL**  
REMEMBER IT'S WATERPROOF

and even powerful chemical fumes cannot turn its color."

"R.I.W." Hospital and Laboratory Enamel is a scientific preparation made for a scientific use. As a sanitary coating for hospitals, milk stations, laboratories, etc., it is giving satisfaction all over the world.

Unaffected by acids, alkalis and chemical fumes, it may be washed with any neutral soap

Write for H. & L. Booklet, Dept. T

## TOCH BROTHERS

Technical and Scientific Paint Makers since 1848

320 FIFTH AVENUE NEW YORK

Works: New York; London, Eng.; Toronto, Can.

**R.I.W.**  
REMEMBER IT'S WATERPROOF  
**R.I.W.**

STEEL NEED NOT RUST!  
WOOD NEED NOT ROT!  
NOR CONCRETE DUST!

REG. U.S. PAT. OFF.

**"ANTI-HYDRO"**  
FOR PERMANENT CONCRETE  
HARDENS WATERPROOFS

**Make Your Concrete  
Pits, Floors and Tanks  
WATERPROOF  
ACID, OIL and ALKALI  
RESISTING**

"Anti-Hydro" hardens and strengthens concrete and protects it from disintegration under water pressure and adverse chemical conditions.

Hundreds of installations, made over a period of twelve years, are giving continuous, uniform satisfaction.

Write for Specifications.

**ANTI-HYDRO WATERPROOFING CO.**

New York Office, Singer Bldg.

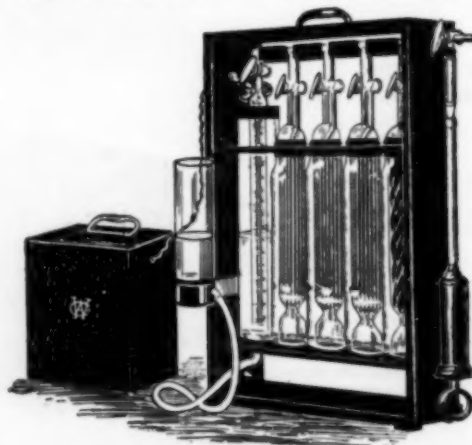
Laboratory, Newark, N. J.

Boston, Detroit, Cleveland, Chicago,  
Louisville, Philadelphia, Washington

## ARE YOU IN THIS LIST?

Every power plant, burning fuel,	Every manufacturer of chemicals,
Every gas manufacturer,	Every smelter,
Every engineering university,	Every iron and steel plant,
Every metallurgical plant,	Every industrial laboratory
Every cement plant,	Every sulphite mill, and many others,

Can Profitably Use a Williams Improved Gas Apparatus.



MODEL A.

For complete analysis of combustible gases. Especially adapted for determination of corrosive gases, chlorine, hydrochloric acid, sulphur oxides, etc.

Write for "Modern Methods and Apparatus for Industrial Gas Analysis," New enlarged edition just coming off the press. Contains tables and much useful information.



**Williams Apparatus Co.**  
Park Place, Watertown, N. Y.



## *Evaporator Installations of Merit*



## EVAPORATORS

ZAREMBA COMPANY, BUFFALO, U. S. A. NEW YORK OFFICE: 95-97 LIBERTY STREET

## If there is anything you want—

or something you don't want that **other** readers of this paper can supply—or use—advertise in the

## Searchlight Section

**NOW—** is the time to offer good second-hand equipment or machinery for sale. The demand is great for good plant for immediate delivery. That's why you should advertise NOW.

**NOW—** or any other time, use the Searchlight Section for advertising

Agencies Wanted  
Agents Wanted  
Auction Notices  
Buildings For Sale  
Business Opportunities  
Civil Service Opportunities  
Contracts To Be Let

Contracts Wanted  
Educational Courses  
Employment Agencies  
Exchanges  
For Rent Items  
Franchises  
Industrial Sites


Miscellaneous Wants  
New Industries Wanted  
Partners Wanted  
Patents For Sale  
Patent Attorneys  
Plants for Sale  
Positions Vacant

Positions Wanted  
Property For Sale  
Receivers' Sales  
Representatives Wanted  
Salesmen Wanted  
Work Wanted  
Etc., Etc., Etc.

ADDRESS ALL COMMUNICATIONS TO THE GENERAL OFFICE

# PORT MORRIS CHEMICAL WORKS, INC.

MANUFACTURING IMMEDIATE PRODUCTS  
FOR THE PIGMENT AND PAINT INDUSTRY



WORKS 141ST ST & LOCUST AVE. CITY  
NEW YORK  
STRAND THEATRE BLDG.  
47TH ST. & 5TH AVE

All agreements are contingent upon terms, accidents or any causes beyond our control. Quotations for prompt acceptance subject to change without notice.

May 22nd, 1917.

Metallurgical & Chemical Engineering,  
Searchlight Dept.

Gentlemen:

It gives us great pleasure to announce the quick result obtained through our advertisement in your valued magazine. We had three Hydro Extractors for sale and with one insertion in your issue of May 15th, the sale was consummated.

The results obtained are the quickest we ever had in our experience and we shall use your medium whenever the opportunity presents itself again.

We are, Very truly yours,  
PORT MORRIS CHEMICAL WORKS INC.

*Albert Baerentzen*

## What ONE Searchlight Adv. did in Less than One Week

FOR SALE

### Tolhurst Hydro Extractors

Two (2) 48" Tolhurst Hydro Extractors, belt driven with plain bottom discharge.

One (1) 48" Tolhurst Hydro Extractor, 110 volt, slightly used.

Twenty (20) 6' by 5' deep, 1/2 inches of reinforcement.

## What the Searchlight Department will do for YOU

### Sell Discarded Apparatus

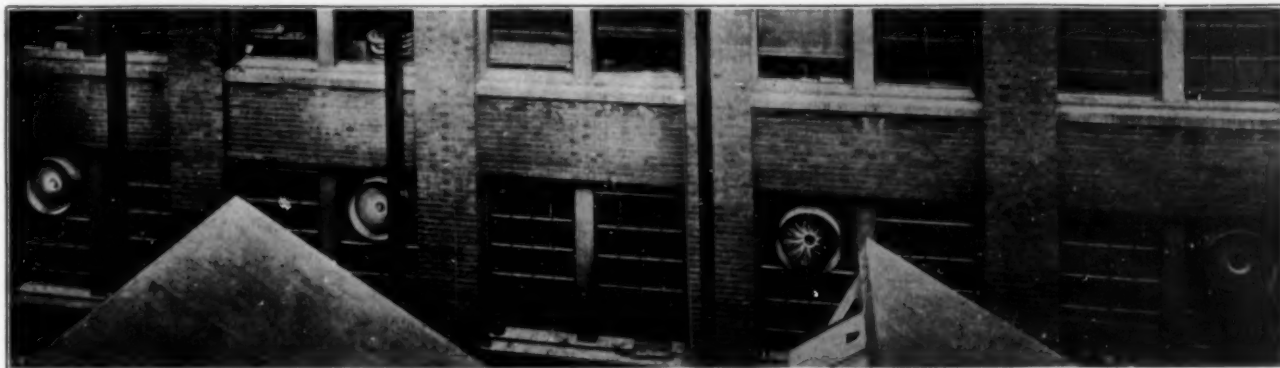
There is a waiting market for any and every piece of Machinery or Equipment which will aid in the manufacture or storage of chemical or metallurgical products. Let this thought be the father to the act of writing out a statement of what you have for sale, to be inserted in the Searchlight Department of "Met. and Chem." It is read by the BUYERS.

### Get the Help You Need

Every incompetent in a job keeps some competent man out of it. The proper employee for the place can be found—by using the Searchlight Department. WORKERS read "Met. and Chem."

### Get You a Better Position

There are lots of them open—there is a market for your abilities. A "Met. and Chem." Searchlight Ad will put you in touch with EMPLOYERS. Advertising rates are low and returns quick.



"Ventura" Fans Ventilating tire department, Firestone Tire & Rubber Co., Akron Ohio,

## "Ventura" Disc Ventilating Fans

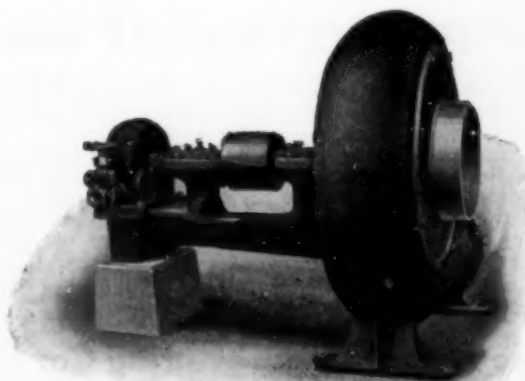
are a most economical and effective means of ventilating the various departments where smoke, gases, fumes and odors are generated.

Cost very little to operate and practically nothing to install. Windows, skylights, etc., offer very good locations for their installation.

Our Engineering Department will gladly tell you how to install "Venturas" to best advantage. Ventura Fans can be driven by either motor or belt. Write for bulletin No. 13025—drop a postal to

**AMERICAN BLOWER COMPANY**  
Detroit Michigan

Canadian Sirocco Co., Ltd., Windsor, Ontario, Manufacturer for Canada



### Ventilation of Chemical Works

requires equipment that is reliable in operation and simple in construction. The Pelton system of ventilation is especially suited for chemical industries, because—

All parts can be made of corrosion resisting materials.

It is moderate in first cost.

It is easily installed.

Replacement parts are inexpensive and quickly put in place.

The Pelton system of ventilation consists of a small water motor directly connected to a blower, and can be used wherever water under a pressure of 30 pounds or more is available. May we tell you more about it?

### The Pelton Water Wheel Company

2187 Harrison St.  
San Francisco, Cal.

87 West St.  
New York, N. Y.

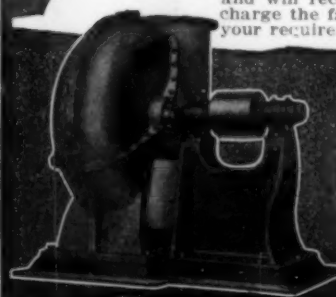
## Sturtevant REGULUS METAL EXHAUSTERS

### Fans For Chemical Plants

The Sturtevant Regulus Metal Exhauster is designed especially for use in chemical plants, and is the result of experiment and experience. The metal is a lead alloy of high tensile strength and withstands the effect of acid or other gases. Great care is shown in the design of the various details and the apparatus gives absolute satisfaction.

These fans are built in various sizes so that your particular requirements can be taken care of.

Our Engineering and Chemical Departments are at your service for advice and will recommend without charge the fan best suited to your requirements.



**B. F. Sturtevant Co.**  
HYDE PARK, BOSTON  
—MASSACHUSETTS—  
and all principal cities of the world



# The Buffalo Spray Nozzle



—for cooling ponds  
—for washing and cooling air

Wherever cooling ponds are used for cooling water for condensers, transformers or water jackets, Buffalo Spray Nozzles should be the choice because—

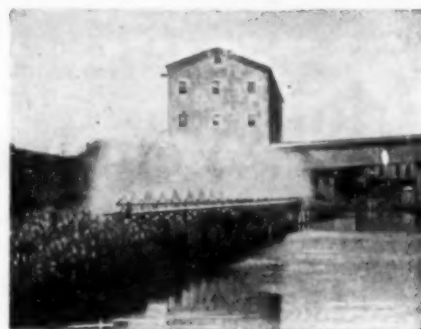
—they give a fine spray on minimum water pressure (15 lbs.).

—the atomizing effect is obtained with large water passages, thus securing freedom from clogging.

—the nozzle is made in only two parts.

These advantages of construction make Buffalo Spray Nozzles equally valuable in washing and cooling air for electrical machinery.

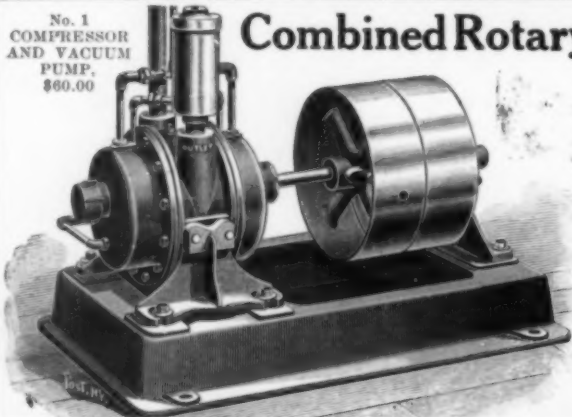
Write for the data on spray nozzle uses. It may point the way to improvements in your work.



Manufacturers of Air Washers, Spray Nozzles, Blowers  
Forges, Drills, Engines, Heating and Ventilating and Drying Apparatus

## Buffalo Forge Co. Buffalo N.Y.

No. 1  
COMPRESSOR  
AND VACUUM  
PUMP.  
\$60.00



### Combined Rotary Air Compressor and Vacuum Pump

THE Crowell Rotary Air Compressor and Vacuum Pumps are the simplest, most compact and efficient apparatus on the market today. Almost noiseless in operation, they are especially adapted for use in College Laboratories. They are made in sizes ranging from 15 cu. in. to 3400 cu. in. per revolution, and will compress air up to 25 lbs. per square inch, or create any vacuum possible under local conditions of the atmosphere.

Ask for Catalog "B," fully illustrating and describing them, also our full line of chemical apparatus.

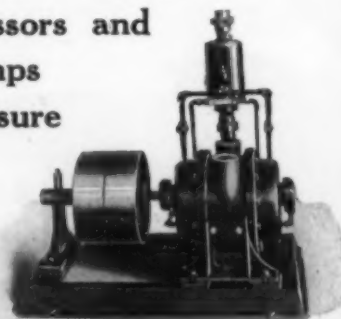
**Buffalo Dental Manufacturing Co.**  
BUFFALO, N. Y., U. S. A.

## CROWELL

Air Compressors and  
Vacuum Pumps  
Positive Pressure  
Blowers

Crowell  
Manufacturing  
Co.

290 Taaffe Place  
Brooklyn, N. Y.



## CONNERSVILLE

Blowers, Gas Pumps, Water,  
Vacuum and Liquor Pumps.

**THE CONNERSVILLE BLOWER CO.**

Connerville, Ind.

Chicago, 929 Monadnock Bldg.

New York, 114 Liberty St.



**U. S. Blow Pipe and Dust Collecting Co.**  
Dust Collecting Engineers and  
Contractors

Send for new Catalogue

2090 Canalport Avenue CHICAGO, ILL.

## The SIMPLEST AIR COMPRESSOR and VACUUM PUMP

### Design

Only three principal parts.

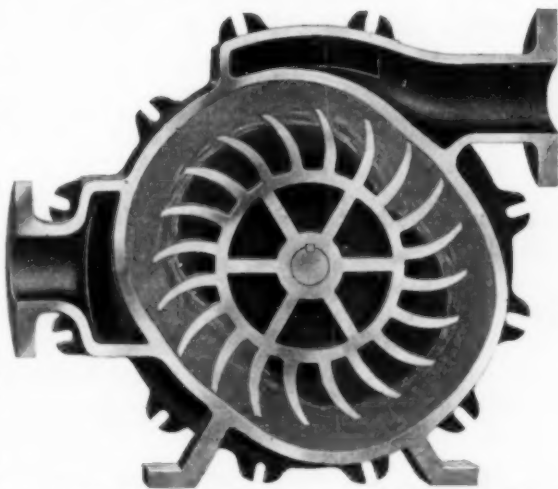
Only one moving part, the rotor.

Shaft is mounted on high grade annular ball bearings outside of casing.

No valves, pistons, rods, crank shafts, loose vanes or gears.

Compression is balanced, eliminating side thrust on the rotor.

Note that rotor runs in casing with large clearance.



**NASH HYDRO TURBINE**

### PRINCIPLE OF OPERATION

The water revolves with the rotor but follows the elliptical casing due to centrifugal force. Twice in a revolution the liquid alternately recedes from and re-enters the rotor. The water acting as a piston compresses the gas.

### Advantages

High Efficiency.

Absolute Reliability.

Air delivered entirely free from pulsation, and therefore can be measured with a Venturi meter.

Air is washed as well as compressed and can contain no oil or other impurities.

Can be constructed of Acid-Resisting Metal.

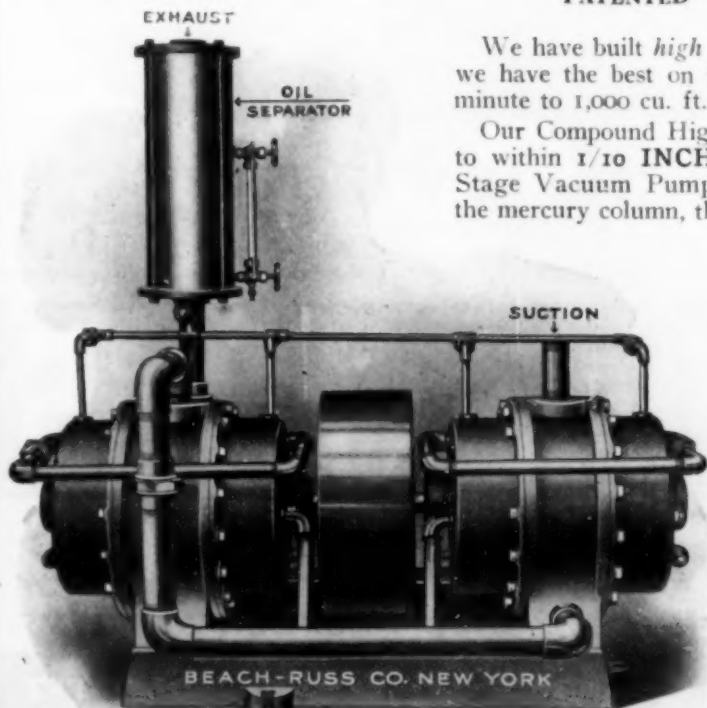
Upkeep cost is practically nothing.

Expert attendant not required.

**NASH ENGINEERING CO., South Norwalk, Conn., U. S. A.**

## Wasteless! Troubleless! Cost less! Wear less! BEACH-RUSS VACUUM PUMPS

PATENTED



We have built *high grade* vacuum pumps for 24 years and know we have the best on the market. We stock 13 sizes, 6 cu. ft. a minute to 1,000 cu. ft.

Our Compound High-Vacuum Pumps are guaranteed to exhaust to within **1/10 INCH OF THE BAROMETER**. Our Single-Stage Vacuum Pumps are guaranteed to show 27" or more on the mercury column, the *barometer being at 30"*.

**Gears? Valves? Springs?  
Complicated Parts? NO!  
Pulsation?**

Quiet and thoroughly reliable operation, with no attention, are characteristic of *Beach-Russ Vacuum Pumps*. Even our special oiling system is automatic and does away with all oil cups. Little floor space required.

We also manufacture Patented Acid Pumps, Positive Pressure Blowers, Filter Presses and Pulverizing Machinery.

**Beach-Russ Co.**  
220 Broadway, New York  
Works, Brooklyn, N. Y.

# CHEMICAL CASTINGS

## SAFETY

The margin of safety in Fulton Foundry Chemical Castings insures:

A generous quantity of quality.

Lasting satisfaction.

Our oldest customers have learned to expect of us the service that comes nearest to anticipating their requirements.

We place at your disposal forty years of foundry and machine shop experience.

Acid Castings, Acid Eggs, Caustic Pots, Kettles, Stills, Retorts, etc.

**Special Machinery** built to specifications, in accordance with our high standard of quality.

**The Fulton Foundry Company**  
Cleveland, Ohio



We design, manufacture and install piping systems for all purposes

**The M. W. Kellogg Co.**  
140 CEDAR STREET, NEW YORK

# LEAD CASTINGS

## FOR CHEMICAL APPARATUS

WE CAN FURNISH HARD LEAD CASTINGS UP TO 10 TONS EACH  
IN THE ROUGH, OR MACHINE FINISHED TO SPECIFICATIONS

**CRAIG FOUNDRY CO.**

42-46 SANFORD STREET  
BROOKLYN, N.Y.



# "UNITED" Acid-Proof Pipe Valves and Fittings

Made and cut accurately to specifications, ready to  
bolt up when received

We relieve you of all worry and work as to details of cutting, fitting and adjusting. Simply furnish us blue prints or plans and we will construct your acid pipe line, including all valves, unions, elbows, tees, flanges, etc., so that everything *will fit* when bolted together, resulting in an acid-proof system which will prove to be a great asset in quick installation and smooth running of your plant.

**United Lined Tube & Valve Company, P. O. Box 3083, Boston**



We have made **LEAD LINED IRON PIPE** over Twenty Years

Be sure that you use  
"Amalgamated"  
Lead Lined Iron  
Pipe—We are  
the only makers  
of that pipe in  
the United States.

Also Lead Lined Iron Valves  
Lead Lined Iron Stop Cocks  
AND

**Tin Lined Iron Pipe**

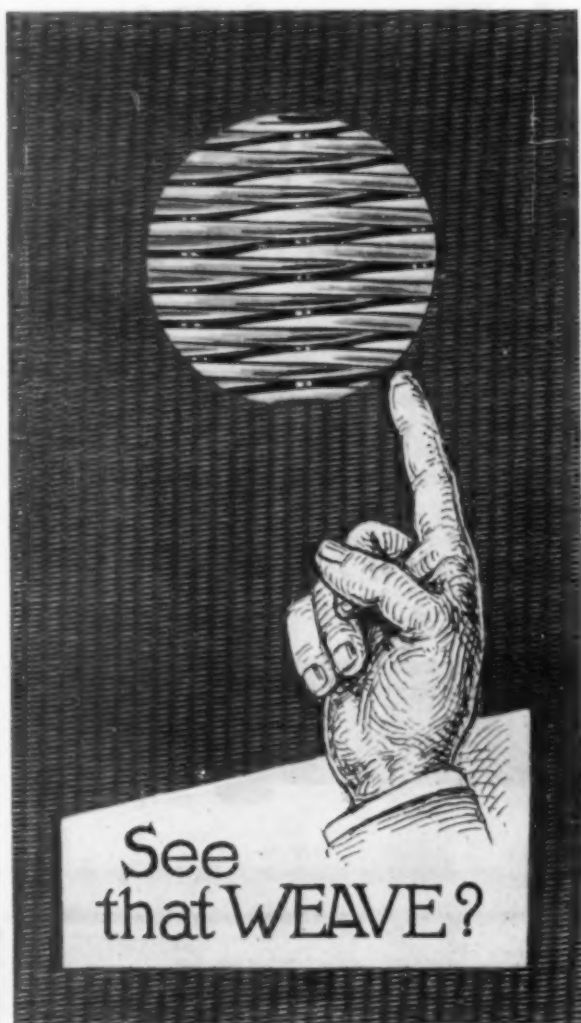
Lead Lined



Iron Valve

MANUFACTURED BY

**LEAD LINED IRON PIPE CO. Wakefield, Mass.**



## MONEL METAL Wire Filter Cloth

(Acid and Alkali Proof)

### Longer Life

The use of short-lived animal or vegetable fibre filter cloths is short-sighted economy. REAL economy suggests the use of the modern filter cloth, made of high tensile strength MONEL METAL wire.

### Greater Efficiency

A special close-woven mesh (see illustration) insures perfect filtration in the most severe service. Proof against both acids and alkalis.

### Write for Data

Our broad experience in solving filtering and screening problems is at your service. Send us your inquiries.

## MULTI-METAL Separating Screen Co.

Makers of Screens from 4 to 350 Mesh in all Metals  
254 W. 19th St. NEW YORK CITY

## Recovering Trade Wastes

Results  
Guaranteed

in connection with Pulp, Paper, Cotton-Mercerizing, Glycerine, Sugar, Coke-oven and Coal-tar products, Benzol, Toluene, etc., etc.

### Evaporation

Largest Builders of  
Evaporating Machinery.

### Distillation

Water, Oils, Solvents,  
Glycerine, etc.

## CHEMICAL APPARATUS

designed and furnished for all purposes. We superintend erection, instruct operators and guarantee correct working.

## Ernest Scott & Company Engineers

Business Founded in 1834

Fall River, Mass.

## MR. CHEMICAL DIRECTOR

This little card is simply to remind you of what you already know—of the standing of the Kestner Evaporator in this country and Europe.

The Aluminum Company of America six years ago replaced their evaporators of other makes with Kestners. They have just purchased their seventh apparatus.

The Hercules Powder Company have recently ordered their second Kestner.

Guanica Centrale, one of the largest sugar houses in the Western Hemisphere—which had used evaporators of other types—after very careful investigation, installed a Kestner, now in its seventh year of successful operation.

Will you not submit your problems and let us include your name among those who are satisfied with their evaporators?

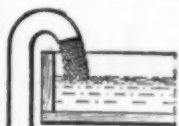
No Entrainment  
No Discoloration  
High Efficiency  
Low Cost of Upkeep  
Scaling Reduced to a Minimum

### KESTNER EVAPORATOR COMPANY

18th St. and Allegheny Ave.  
Philadelphia, U. S. A.

## Lifting Acids

Lifting and transferring of acids from one place to another may be accomplished by means of Lead or Lead Lined Centrifugal Pumps, Air Jet Lifts, or by the

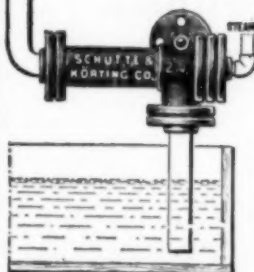


### KOERTING LEAD LINED ACID SYPHON

The Acid Syphon is invariably found to meet most all conditions (except where slight heating or diluting of the acid is objectionable) more satisfactorily than any other pump, because,

1. It is convenient to install.
2. Easy to transport when desired.
3. Requires little space.
4. Easy to manipulate.
5. Requires little attention.
6. No working parts.

Where conditions require we supply either Hard Lead Centrifugal Pump or the



### KOERTING AIR JET LIFT

which latter is made of suitable material, like the Syphon (Brass, Iron, Lead, Hard Rubber, Stoneware or Porcelain) to withstand chemical action of the liquid, and are described in detail in our

CHEMICAL CATALOGUE

## Schutte & Koerting Company

Thompson and 12th Sts. Philadelphia, Pa.

New York, 50 Church St.; Boston, 132 High St.; Kansas City, Burton Machy. Co.; Denver, 1st Nat. Bank Bldg.; Chicago, Security Bldg.; Pittsburgh, Keenan Bldg.; Cleveland, Union Bldg.

## The HAYWARD is a Comfortable Respirator



The Hayward Respirator

A safety device that annoys the wearer will soon be discarded. Comfort is essential. The Hayward Respirator fits the face closely but without discomfort because of the pneumatic rubber face cushion. The Hayward is light, simple, and strong in design with all metal parts of aluminum. A double filtering device protects the wearer from smoke, gas or dust.

Write for Safety Catalog.

## AMERICAN LAFRANCE FIRE ENGINE COMPANY, INC.

Elmira, N. Y.

Atlanta  
Baltimore  
Boston  
Chicago

Dallas  
Denver  
Los Angeles  
Minneapolis  
San Francisco

New York  
Philadelphia  
Pittsburgh  
Portland, Ore.

Toronto, Ontario, Canada.

Manufacturers of Safety Devices for every purpose

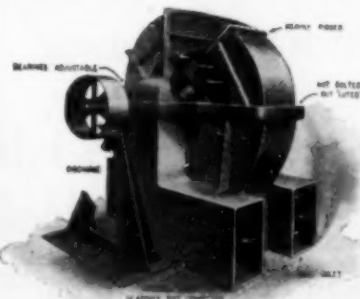
## We Specialize in Pure Silver Pipe RODS WIRE SHEETS

Also many specialties for the chemical and allied industries. Your inquiries are solicited.

A. T. Wall Co.

162 Clifford St., Providence, R. I.

## The Heinz-Skinner Acid Fan



Extensively used for furnishing induced draft in sulphuric acid chambers.

U. S. Steel Corporation has 12 in use.

American Zinc Co. of Illinois, 10 in use.

Western Chemical Mfg. Co., 4 in use. Aetna Explosives Co., 4 in use.

American Zinc & Chemical Co., 4 in use.

The Stearns-Roger Mfg. Co., Denver, Colo.

# LUNKENHEIMER

## Non-corrosive (ANTI-ACID) VALVES

For vapors and liquids of any pressure and temperature, are made of special alloys to meet service conditions in the chemical industry.

Our Laboratory Division will assist you in selecting the proper type of valve and the metal best suited to the purpose.

When writing give complete description of the fluid to be handled; whether vapor or liquid, together with the pressure, temperature and its chemical composition.

The complete line of Lunkenheim High-grade Engineering Appliances consists of Bronze, Iron, Puddled Semi-Steel and Cast Steel Valves; Boiler Mountings, Ground Key Work, Injectors and Ejectors; Lubricators, Oil Pumps, Oil and Grease Cups; Fittings, Motor Accessories, etc. Write for descriptive literature.

THE LUNKENHEIMER CO.

"QUALITY"

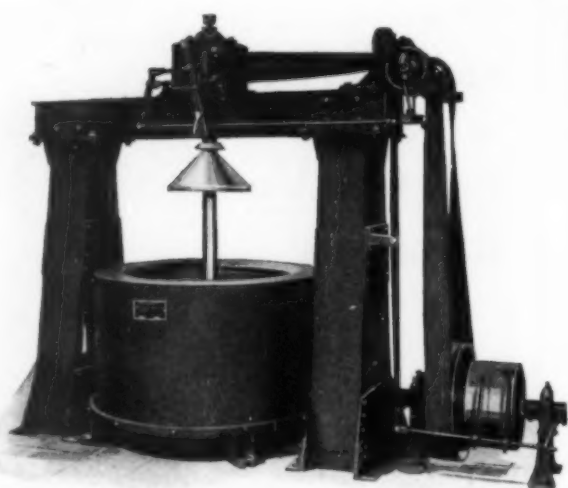
NEW YORK  
CHICAGO

CINCINNATI

BOSTON  
LONDON

FOR USE WITH  
**Acids, Alkalis, Salts**  
and other **Corrosive Agents**





## Tolhurst Suspended Centrifugal

made with or without  
bottom discharge

**Tolhurst Machine Works**  
Troy, New York

Southern Agents:

**FRED H. WHITE**  
Realty Bldg., Charlotte, N. C.

New York Representative:

**FRED A. TOLHURST**  
106 Central Park West, New York City

Western Representative:

**JOHN S. GAGE**  
Hartford Bldg., Chicago, Ill.

## "Flotation Oil" Plants WITH BY-PRODUCT RECOVERY

We have over 75 years' experience in making plants for producing all grades of Pine Oils, Rosin Oils, Wood Oils, Wood Creosotes, etc.

By recovering the by-products it is in most cases possible to produce the oil most suitable for your particular treatment, free of cost.

Advise us as to kind and quantity of wood available and amount of oil required per day, and we will submit a specification.

## Wood Tar Distillation PRODUCING WOOD CREOSOTE (USP) GUAIACOL OILS, Etc.

Plants in operation on both the Continuous and Batch Systems doing 100 tons per week.

**Blair, Campbell & McLean, Ltd.**  
GLASGOW, SCOTLAND

Established 1838

Cables, "Blazon, Glasgow" A.B.C. 5th Ed.

# When You Need Mechanical Engineering Data—Then You Need Marks' Handbook

## Brief List of Contents

### MATHEMATICAL TABLES AND WEIGHTS AND MEASURES—MATHEMATICS

Arithmetic, Elementary Geometry and Mensuration, Algebra, Trigonometry, Analytical Geometry, Differential and Integral Calculus, Graphical Representation of Functions, Vector Analysis.

### MECHANICS OF SOLIDS AND LIQUIDS

Mechanics of Rigid Bodies, Stresses in Framed Structures, Friction, Hydraulics.

### HEAT, STRENGTH OF MATERIALS, MATERIALS OF ENGINEERING

General Properties of Materials, Iron and Steel, Iron and Steel Castings, Non-ferrous Metals and Alloys, Corrosion, Paints and Protective Coatings, Cement, Mortar and Concrete, Wood, Fuels, Miscellaneous Non-metallic Materials, Lubricants.

### MACHINE ELEMENTS

Mechanism, Machine Elements, Elements of High-speed Machines, Pipe and Pipe Fittings, Wire Rope, Nails, etc.

### POWER GENERATION

Steam Boilers, The Steam Engine, Steam Turbines, Condensation, Internal-combustion Engines, Gas Turbines, Water Wheels, Hydraulic Turbines, Cost of Power.

### HOISTING AND CONVEYING

Hoisting Machinery, Conveying Machinery.

### TRANSPORTATION

Automobiles, Railway Engineering, Marine Engineering, Aeronautics.

### BUILDING CONSTRUCTION AND EQUIPMENT

Building Construction, Reinforced-concrete Construction, Industrial Buildings, Heating and Ventilation, Air Conditioning, Illumination, Prevention of Accidents, Fire Protection.

## Lionel S. Marks, Editor-in-Chief

Professor of Mechanical Engineering, Harvard University and Massachusetts Institute of Technology.

Assisted by over 50 specialists

Marks' Mechanical Engineers' Handbook covers the whole field of mechanical engineering.

It contains 1836 pages—every one packed with facts, formulas, figures and information useful to every man who ever needs mechanical engineering data.

No matter what kind of work you are engaged in, if it has to do with mechanical engineering, you'll find that always having a copy of Marks' Handbook within easy reach pays you—and pays you big.

## The Handbook of Authority

Marks' Handbook has been called "the Handbook of Authority." It's not hard to see the reason for that. For "Marks" represents a distinct step in the progress of engineering literature—the production of a big useful handbook by a staff of specialists, each an acknowledged leader in his field. Over fifty specialists collaborated in the preparation of "Marks."

This means that all the information you find in it—every formula, every figure, every table—bears the stamp of unquestioned authority.

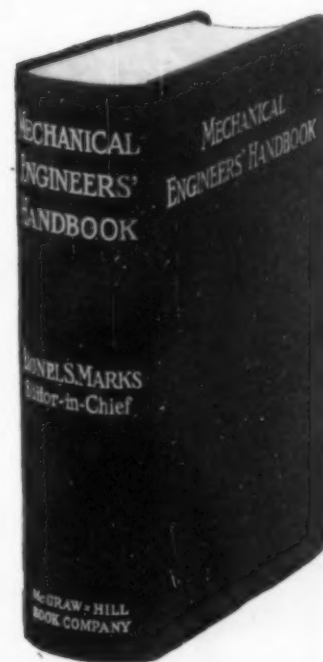
## It Places Mechanical Engineering At Your Fingers' Ends

Data on every phase of mechanical engineering is within easy reach—right at your fingers' ends—in Marks' Handbook.

A complete system of indexing renders everything easily accessible. "Marks" gives you the data you want—and gives it to you quickly.

## Send No Money—Just the Coupon

Our belief in the real, every-hour-of-the-day usefulness of Marks' Handbook is backed by our unqualified offer to send you a copy postpaid for free examination—no obligation to purchase. This enables you to examine it for ten days in your home or office. You don't pay a cent until the book has demonstrated its value to you. Fill in and mail the coupon below today—now.



## Brief List of Contents (Continued)

### MACHINE-SHOP PRACTICE

Machine Tools and Machine-shop Practice, Electric Drives, Industrial Management, Cost and Other Factory Accounts.

### PUMPS AND COMPRESSORS

Pumps, Centrifugal Pumps, Air Compressors, Centrifugal Compressors, Centrifugal Fans.

### ELECTRICAL ENGINEERING, ENGINEERING MEASUREMENTS, MECHANICAL REFRIGERATION, ETC.

Measuring Instruments, Surveying, Mechanical Refrigeration, Patents for Inventions, First-aid Treatment, Miscellaneous, A. S. M. E. Testing Codes.

**McGraw-Hill  
Book Co., Inc.**

239 West 39th St.  
New York

## CLIP THIS COUPON

McGraw-Hill Book Company, Inc.,  
239 West 39th St., New York.

You may send me on 10 days' approval Marks' Mechanical Engineers' Handbook, \$5.00 net.

I agree to pay for the book or return it postpaid within 10 days of receipt.

...I am a regular subscriber to Met. & Chem. Eng.

...I am a member of the A. I. M. E. Member Am. Electro-Chem. Soc.

Signed .....

Address .....

Reference ..... M 6-15

(Not required of subscribers to Met. & Chem. Eng. or members of A. I. M. E. or Am. Electro-Chem. Soc. Books sent on approval to retail customers in U. S. and Canada only.)

*Leather, pocket size, gilt edges, thumb indexed, 1836 pages, about 1000 illustrations and diagrams, \$5.00 (21s) net, postpaid.*

## Monel Metal Centrifugal and Filter Cloth

Fine meshes of wire cloth, in either Monel Metal or Copper, particularly centrifugal and filter cloth, are now available.

**B & G**  
WIRE  
PRODUCTS

include cloths, fine or coarse, light or heavy, for every purpose where accuracy is required. Let us send you samples and prices.

**Supplee-Biddle Hardware Co.**

513 Commerce St.  
Philadelphia

30 Church St.  
New York



## FILTER PRESSES

We manufacture a complete line of filter presses for use in chemical, electro-chemical works and the glue, ink, paint, oil, battery, carbon, graphite, paper, powder, rubber, salt, soap, sugar and dye and color industries.



Special presses built with wood plates and frames, also of bronze and other acid and alkali-resisting metals.

The  
**Allbright-Nell Co.**  
Manufacturers  
Chicago, Ill.

A Perfect Press for General Work  
Made in four sizes—18 in., 24 in., 30 in., 36 in. square. Recessed Plates. Center Feed. Open Delivery.

## FILTER PRESSES



Laboratory Press designed for making practical tests.

We build Iron Plate and Wood Plate Presses in all sizes from 12 to 40 inches.

Write for  
information  
and prices

**WILLIAM R. PERRIN & COMPANY**  
OLD COLONY BUILDING, 3 CHICAGO, ILLINOIS

## Centrifugal Linings and Filter Press Plates

Steel, Copper, Brass, Aluminum, Lead, Zinc, Tin and other metals or materials perforated as required.

Perforated Metals of Every Description  
Our catalog sent you on request

**Chas. Mundt & Sons**  
494 Johnson Ave. Jersey City, N. J.

## ACID-PROOF FILTER PLATES FILTROS

**GENERAL FILTRATION CO., INC.**  
Cutler Bldg. Rochester, N. Y.

## "ACIMET" Acid-Proof VALVES

(Trade Mark Registered) (Patented)  
mean 100% efficiency in controlling sulphuric acid and other corrosive liquors. Heavy, reinforced construction; will not corrode; are permanent. Wear-reducing disc and seat. Get free trial proposition.

**The Cleveland Brass Mfg. Co., Sole Manufacturers**  
4612 Hamilton Ave., Cleveland, Ohio



## WE ARE FILTRATION ENGINEERS

Untiring attention to details is part of the service you buy with Sperry Filter Presses. It is this expert service, both on the part of engineers and mechanics, which has established the quality character of

# SPERRY FILTER PRESSES



At the left is shown a Sperry double-ended 36" Filter Press built to accommodate 100 plates. The picture gives some idea of its rugged strength.

At the right is shown a "close up" view of the gear closing device of the Sperry double-ended Filter Press. The frame work was made long enough to accommodate 15 additional plates in each end. Total capacity 100-36" plates.

Send for our new catalog. It is a text book on the subject of Filtration.



### D. R. SPERRY & CO., Engineers and Manufacturers

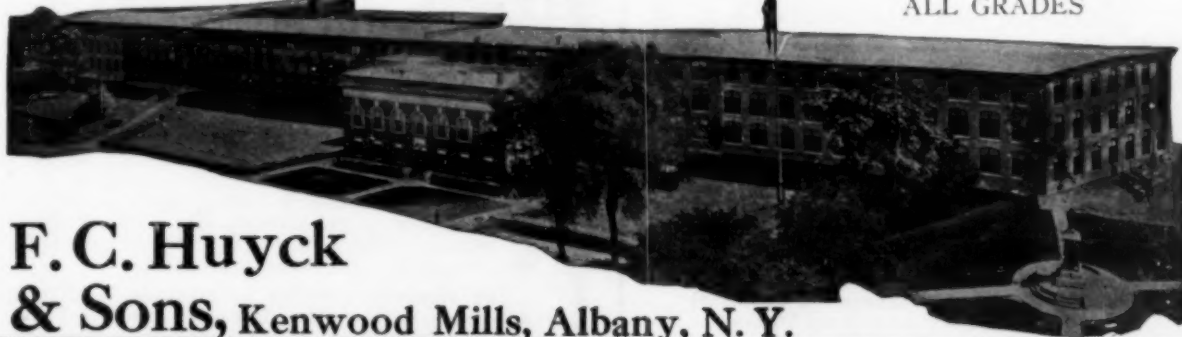
New York Agent: H. E. JACOBY, 95 Liberty St.

Batavia, Ill., Near Chicago

## EVERYTHING BUILT IN OUR OWN SHOPS

To American Users of Filter Cloths and Paper Makers' Felts  
*Save money* by getting your supplies from this mill

ALL THICKNESSES  
 ALL GRADES



**F. C. Huyck  
 & Sons, Kenwood Mills, Albany, N. Y.**

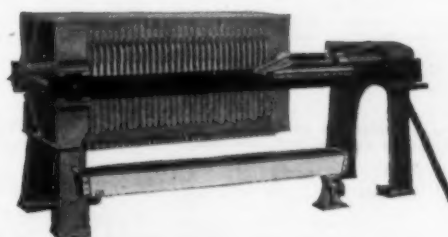
## THE "JOHNSON" FILTER PRESS

*Backed by 38 years' experience*

Over 15,000 in use

**JOHN JOHNSON COMPANY**

37th Street and Second Avenue, Brooklyn, New York





**"Meets  
a real  
need"**

—Jr. Ind. &  
Eng. Chem.

## A German-English Dictionary For Chemists

By Austin M. Patterson, Ph.D. (Johns Hopkins), formerly Editor of Chemical Abstracts; Editor of Chemical Terms for Webster's New International Dictionary.

The Jr. of Industrial and Engineering Chemistry also said:

"Dr. Patterson has performed a public service in the compilation of his German-English Dictionary for Chemists. . . . All chemists will understand the particular value of such a dictionary if they will recall their early efforts to read the German chemical journals."

This book contains over 30,000 definitions, and includes terms from all branches of chemistry. Every chemist should have this volume; it is indispensable. Have a copy sent for free examination. The coupon below is for your convenience.

332 pages, 5 x 7, Flexible binding, \$2.00 net.

## Books on Materials

**UPTON—The Structure and Properties of the More Common Materials of Construction**

This book covers all the more common materials, alloys, steels of different types, cast iron, bronzes and bronzes, cement and concrete, plain and reinforced, and testing thereof.

332 pages, 6 x 9, 181 figures. Cloth, \$2.50 net.

**MILLS—Materials of Construction**

**Their Manufacture, Properties and Usage**

Covers the manufacture, properties and uses of the more common materials of engineering construction, in a concise and thoroughly modern manner.

703 pages, 6 x 9, 346 figures. Cloth, \$4.50 net.

**JOHNSON—Rapid Methods for the Chemical Analysis of Special Steels, Steel Making Alloys and Graphites**

2nd Ed., Rewritten

This book conforms with the latest and best analytical practice in iron, steel and its alloys.

448 pages, 6 x 9, 39 figures. Cloth, \$3.00 net.

## FREE EXAMINATION COUPON

**JOHN WILEY & SONS, Inc.**

432 Fourth Ave., New York City.

Gentlemen: Kindly forward me for 10 days' free examination copies of the following books:

.....

I agree to remit the price of these books within 10 days after their receipt, or return them, postpaid.

Name .....

Address .....

(Mention on the above line the National technical society of which you are a member. If not a member of any society, you can give a reference, or indicate your position. This offer is also extended to subscribers to Met. & Chem. Eng.) M. & C. E. 6-15-17

**ELYRIA**  
GLASS ENAMELED  
**EQUIPMENT**



Heat and cool it quickly—  
no cracking or scaling  
Acids will not corrode it  
Leaks and weak  
points unknown

Elyria Glass Enameled Lining, chemically resistant and fused to the seamless steel shells at 2000° F, refuses to give way under the considerable stresses of alternate heating and cooling.

The slightest possibility of weakness in Elyria Apparatus, whether Glass Enameled Lined or Plain, has been eradicated by the Autogeneous Welding of all seams in the steel shells.

Elyria Apparatus is leakless and safe in all ways. Supplied in standard or special designs, enameled or not enameled. Ask for Catalog B.

**The Elyria  
Enameled Products Co.**

Elyria, Ohio

New York:  
50 Church Street

Chicago:  
1033 W. Lake Street

Pittsburg:  
1237 Oliver Bldg.

San Francisco:  
16 California Street

Los Angeles: 320 Story Bldg.



## Dorr Equipment for Chemical Industry

The many years of careful study which we have given to the problems in hydrometallurgy and which have earned for Dorr Equipment such remarkable success is directly responsible for the many new applications of our machines in the Chemical Industry.

The installation of the **Dorr Classifier** (*or washer*), the **Dorr Thickener** (*or dewaterer*), the **Dorr Agitator** (*or mixer*), has in many instances been the means of recovering values which previously were lost. By their low cost of operation and small amount of attendance they have demonstrated their practicability in:

Making Caustic Soda continuously from Soda Ash and Lime—Fine grinding of Silica for Pigments and Glass—Washing Phosphate Rock free from Clay—Reclaiming Organic Wastes—Recovering Water from Coal Washeries—Sewage Disposal—and many other uses which space does not permit mentioning.

*Ask us to send you Bulletin C 8*

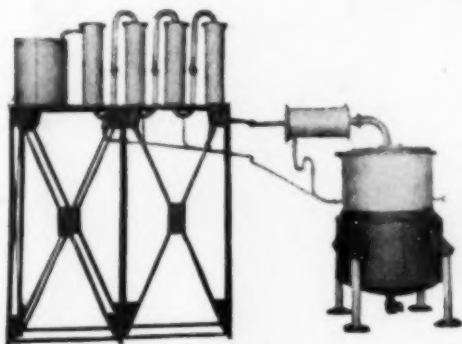
### THE DORR COMPANY ENGINEERS

New York  
17 Battery Place

Denver  
1009 17th Street

London, E. C.  
16 South Street

## Recovery and Fractionating of Alcohol



Pat. Applied For.

What a saving the re-use of your alcohol would be! Now, how to get it.

If It Is in Excess in Solids, Evaporate and Then Condense It.

If It Is Mixed with Other Liquids, Fractionate off the Alcohol.

Either type of apparatus, or both, can be supplied to you by us, promptly.

*Our Fractionating Apparatus is low and can be installed within  
the height of an ordinary room.*

### L. O. Koven & Bro., Manufacturers

Main Office: 154 Ogden Avenue, Jersey City, N. J.

New York Office: 50 Cliff Street





One-piece, jacketed, closed, Enameled Mixing Tank. The Propeller-type Agitator shown through fracture is steel, Glass Enameled.

## PFAUDLER

### GLASS ENAMELED STEEL TANKS AND APPARATUS

give the Manufacturer of chemicals greater strength per pound in his equipment, and greater capacity per foot of space utilized than any other type of corrosion-resisting, cleanable apparatus.

The Glass Enamels which we have developed in our 30 years' career have unusual resistivity and density, and are thoroughly fused *into the steel* by the process which we originated.

Get Bulletin C-4 out of your file—or send for it. It may suggest a way out of your present difficulties.

**The Pfaudler Co.**  
Rochester, N. Y.

New York,  
110 West 40th St.

Chicago,  
1001 Schiller Bldg.

San Francisco,  
512 Sharon Bldg.

**35  
Years**

devoted to  
the design  
and con-  
struction of

**Special  
Apparatus**

has given us  
proficiency in  
this line of  
work.



**Copper Kettle**

Standard 150 Gal. Varnish Kettle

Steam Jacketed Copper Kettles, Vacuum Pans, Copper Still, Condensers, Seamless Copper Coils, Coating Pans, Varnish Kettles, etc., etc., built entirely in our own shops. Workmanship and prompt deliveries are backed by these many years of experience.

We also manufacture Cold Process Gas Plants.

Write for Catalogue.

**Detroit Heating & Lighting Co.**  
(Established 1868)  
Detroit, Mich.

## MOTT'S KETTLES

All  
Sizes

All  
Kinds

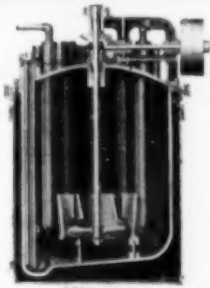


Steam Jacketed Kettle

Made in plain cast iron from 5 gallons to 3000 gallons. Made with lining of acid-resisting enamel in sizes from 5 gallons to 100 gallons.

Send for Circulars.

**The J. L. Mott Iron Works**  
118 Fifth Avenue, New York



Nitrator



Reducer



Washer

## To the men interested in CHEMICAL EQUIPMENT

these photographs—show-  
ing equipment actually  
built—speak eloquently of  
the result of our 15 years  
specialization in this single  
field. Write us.



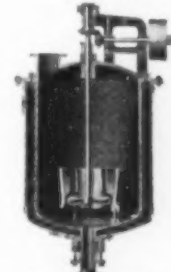
**STEVENS BROTHERS**

*Engineers—Contractors*

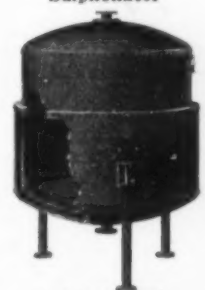
*Room 929—149 Broadway—New York City*



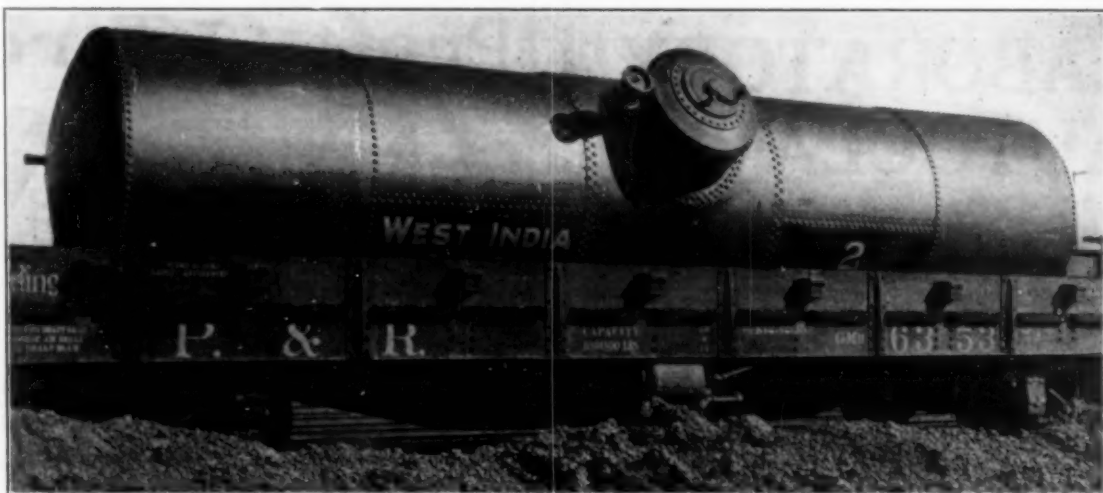
Sulphonator



Sulphonator



Jacketed Still



Shipment 8 to 16 Weeks

## TANK CARS

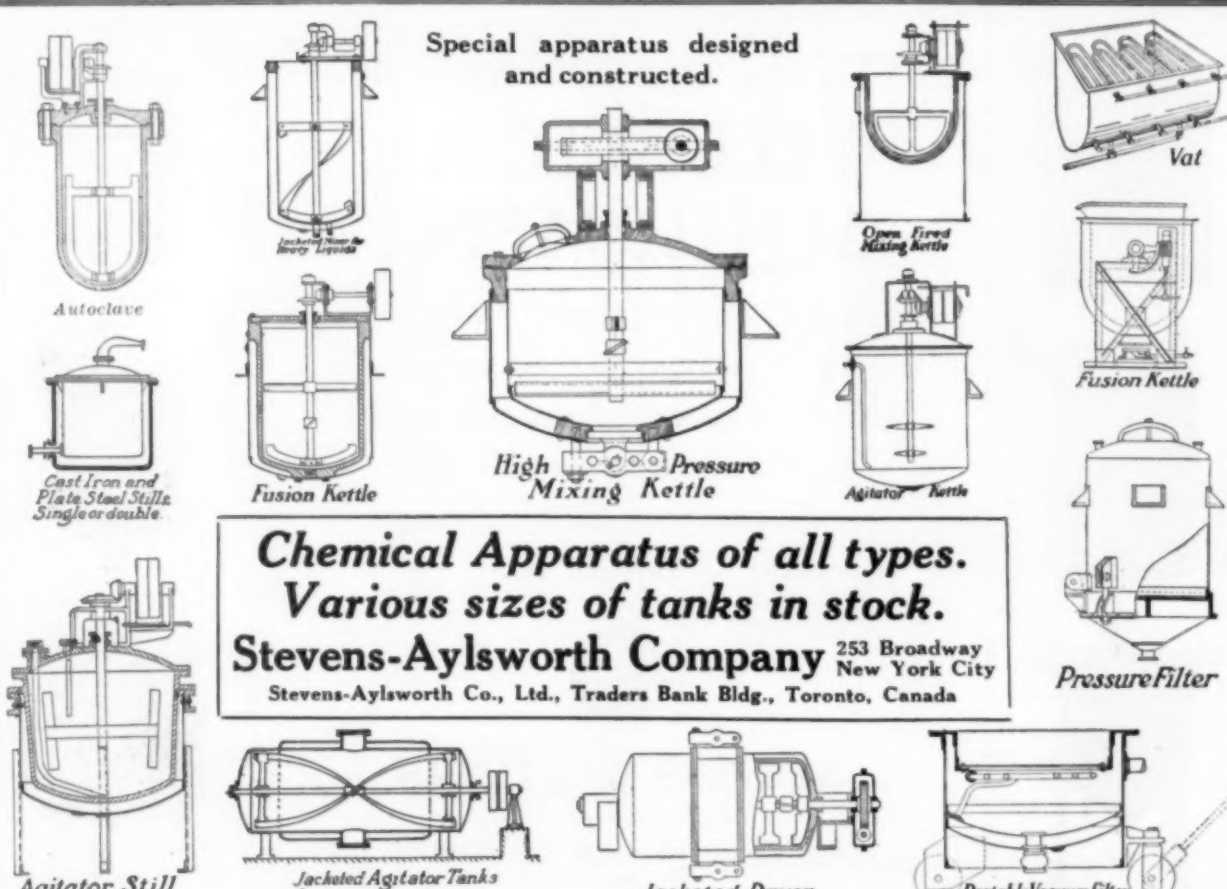
(Complete with Trucks)

For Chemicals, Acids, Oils, Molasses, Chlorine, Etc.

Steel Tanks, Dryers, Mixers, Kiers, Digestors,  
Evaporators and riveted steel construction of any kind.

**Aetna Steel Products Co., Inc., 36 Church St., New York**

Special apparatus designed and constructed.



Autoclave

Jacketed Stirrer

Open Fired Mixing Kettle

Vat

Cast Iron and Plate Steel Stills Single or double

Fusion Kettle

High Pressure Mixing Kettle

Agitator Kettle

Pressure Filter

**Chemical Apparatus of all types.**  
**Various sizes of tanks in stock.**  
**Stevens-Aylsworth Company** 253 Broadway New York City  
 Stevens-Aylsworth Co., Ltd., Traders Bank Bldg., Toronto, Canada

Agitator Still

Jacketed Agitator Tanks for pressure or vacuum

Jacketed Dryer

Variable Vacuum Filter

## LABORATORY AUTOCLAVES

All Sizes,  
 All  
 Pressures,  
 Jacketed  
 or Plain  
  
 With or  
 Without  
 Mechan-  
 ically  
 Actuated  
 Agitators



### VALLEY IRON WORKS

Williamsport, Pa., U. S. A.

## The Acetylene Blow Torch Prest-O-Torch

Quicker and cheaper  
 than a gasoline blow-torch  
 for brazing and soldering

For factories, foundries, repair shops, linemen, the Prest-O-Torch saves time and money. Used with Prest-O-Lite Tanks—ready-made gas. Intense, concentrated flame is instantly lighted. No depreciation, safe and convenient. Style "A," price 75c (Canada, 85c) will braze up to  $\frac{3}{8}$  inch round rod. Style "C" for heavier work, \$2.25 (Canada, \$2.75). Special styles for dentists. Write for literature, or send order now. Money refunded if not satisfied.

The Prest-O-Lite Co., Inc. 819 Speedway  
 Indianapolis Ind.  
 Canadian Main Office & Factory, Merriton, Ont.

## A. J. WEEKS

Manufacturer of  
 Acid-Proof Chemical Stoneware  
 "Ask the Man Who Uses It"  
 Oldest Manufacturer of Chemical Stoneware in  
 Akron, Ohio

**Stoneware** of any description  
 for all purposes

Chas. Graham Chemical Pottery Works  
 986 Metropolitan Ave. Brooklyn, N. Y.





Vacuum Pan with full jacketed bottom half, coils for extra heating and cooling surface, and outside sweep mixer. Any size up to 1600 gallons.

## You can depend upon Dopp Seamless One-Piece Apparatus

### Kettles—Mixers—Vacuum Pans

Trouble-free manufacture involving the operations of cooking, heating, boiling, etc., will be arrived at so far as your equipment is concerned, by safeguarding against leakage, waste of time and waste of fuel.

Because Dopp Apparatus is cast without seams, joints or rivets and has thin, smooth walls which do not require machining, it cannot leak, heats and cools quickly, and saves heat.

After fifty years of building this type of apparatus we recommend it as superior in every way that counts for your profit, and we unhesitatingly guarantee it for life against defective materials and workmanship.

But it is the idea—the design—the Dopp method—which counts most.

Realize the extent and importance of the Dopp line by sending for Catalog V, Section I.

**ADOPT THE DOPP**

**Sowers Manufacturing Co.,** 1302 Niagara St., Buffalo, N. Y.  
30 Cortlandt St., New York City

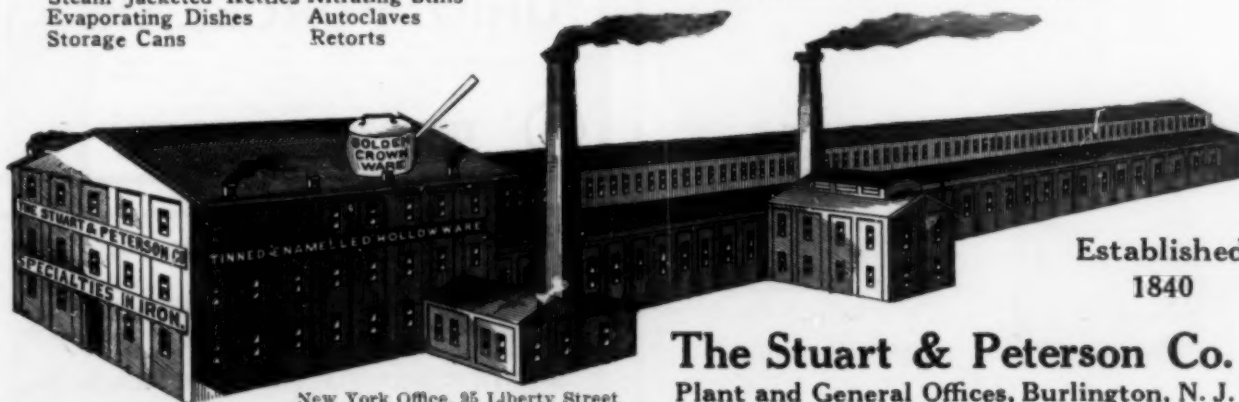
## Long Experience and Huge Facilities enter into the manufacture of Stuart & Peterson Apparatus for the Chemical Industries

Vacuum Stills  
Steam Jacketed Kettles  
Evaporating Dishes  
Storage Cans

Tanks  
Nitrating Stills  
Autoclaves  
Retorts

We will supply acid-proof porcelain-lined or plain apparatus in a large number of stock patterns, or made to order after your specifications.

*We solicit the opportunity to quote on your needs.*



Established  
1840

**The Stuart & Peterson Co.**  
Plant and General Offices, Burlington, N. J.

New York Office, 95 Liberty Street



Not "just as good"  
but the

**Best  
Porcelain Ware  
The World Can  
Supply**

*And this is a long estab-  
lished fact*

## GUERNSEY WARE

is the product of the first American manufacturers of Chemical Laboratory Porcelain. Every piece is made of the finest selection of clays, and our methods of manufacture insure maximum life. A complete line for you to select from.

Handled by 57 Supply Dealers throughout the United States and Canada.

**The Guernsey Earthenware Company**  
44 East End Street, Cambridge, Ohio, U. S. A.

**SPECIFY THROUGH YOUR DEALER**

On your next Chemical Order—

*Specify*

**"BAKER'S  
Analyzed"**

**Chemicals & Acids**



After a trial you will specify them on ALL your orders, because you will find them dependable reagents of the highest quality and uniformity.

An Accurate Analysis  
Appears on the Label of  
Each Bottle.

*Catalogue on Request*

**J. T. Baker Chemical  
Co.**

Phillipsburg, N. J.

## Laboratory Apparatus Co.

Incorporated 1917. State of Pennsylvania

Importers—Manufacturers—Dealers

Apparatus—Chemicals and Supplies

*For*

Industrial and Chemical Laboratories  
Scientific and Educational Institutions

800-802 Penn Avenue

**Pittsburgh, Pa.**

## "OHIO" PORCELAIN ©

is perfectly tempered and is giving universal satisfaction. "Ohio" Glassware has a reputation for great resistance. We carry a full line of both; also laboratory supplies.

*Write for samples and prices.*



**THE LABORATORY SUPPLY CO.**  
236 N. 3rd Street, Columbus, Ohio

## American Headquarters for Filter Papers

We have a large stock of the best European acid washed, chemically pure and folded filters, also an excellent American paper for qualitative work.

**SCIENTIFIC MATERIALS CO., PITTSBURGH, PA.**

# Chemical Stoneware and Bricks

*Largest Plant—Greatest Output*



*Everything  
in Stoneware  
and Bricks.  
Our elaborate  
Catalog on  
your request.*



THE U.S. STONEWARE CO., AKRON, OHIO.

With pardonable pride we invite you to ask the largest users of chemical stoneware what they think of our product.

They doubtless will tell you, as they do us, that "it is the most satisfactory Stoneware we have ever used."

## The U. S. Stoneware Co.

Established 1865 Akron, Ohio, U. S. A.  
Office and Factory No. 1, 160 to 172 Annadale Ave.  
Factory No. 2, 221 to 273 Fountain St.



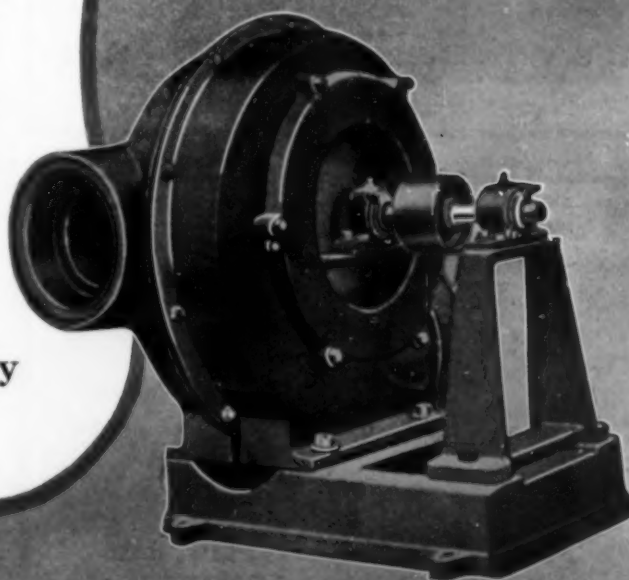
## Chemical Stoneware

produced by experienced,  
careful workmen

The world hurries about its affairs these days—and while the RUSH spirit is to be found in our plant, it never dominates the policy that says: "Quality First." We have purchased and developed new plants and built new factories—and today we are in a position to fill any orders for Chemical Stoneware satisfactorily.

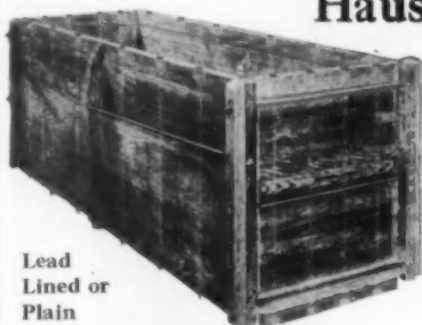
**General Ceramics Company**  
50 Church Street, New York

Formerly German-American Stoneware Works





## Hauser-Stander Tanks



Lead  
Lined or  
Plain

were among the first in the metallurgical and chemical field. Through careful study of the requirements in this field

### HAUSER-STANDER TANKS CONTINUE TO LEAD

every H-S Tank is built to meet your special need.

**Wooden Tanks  
for every purpose**

**The Hauser-Stander Tank Co.,** 2120 Division St.  
Cincinnati, Ohio



## VATS TUBS AND TANKS

We equip your entire plant, using only the best of material and the highest order of workmanship.

### Ask for quotations

on your sulphur towers, treating tanks, generators, settling tanks, steepers, fermenters, neutralizers, measuring and acid tanks, yeast tubs and storage tanks.

**U.S. WIND ENGINE & PUMP CO.**  
BATAVIA, ILLINOIS  
15 Water Street

## This Is Why Caldwell Steel Tanks Satisfy



—Carefully designed according to approved engineering principles.  
—Correctly and thoroughly riveted.  
—Made by first-class workmen in an up-to-date steel tank shop.  
—And therefore absolutely safe and non-leakable.

Send for Catalogue

**W. E. CALDWELL CO.**  
Incorporated  
2130 BROOK ST., LOUISVILLE, KY.

*Caldwell*  
TANKS  
AND  
TOWERS

## Widely used in place of lead lined tanks for chemical work



Also **Remco Redwood Bored Pipe**, for acid and alkaline solutions, pulps, slimes, sands, etc.

**Redwood for Durability  
Remco for Mechanical Perfection**

**Redwood Manufacturers Company**  
1620 Hobart Building, San Francisco, Cal.

## Quality First!



The man who has once bought a "cheap" tank appreciates on the next purchase the opportunity of doing business with that manufacturer whose character and reputation have been built on a "quality first" foundation.

For tanks for chemicals it is a safe plan to rely upon

**A. J. CORCORAN, Inc.**

Established 1865 755 Jersey Ave., JERSEY CITY, N. J.

## Challenge Tanks of All Descriptions

Made to specification from Fir or Cypress, for any purpose. Our experience and high standards of manufacture assure you satisfaction. Only 100 per cent perfect workmanship and material leaves our factory. "Get Challenge details first."

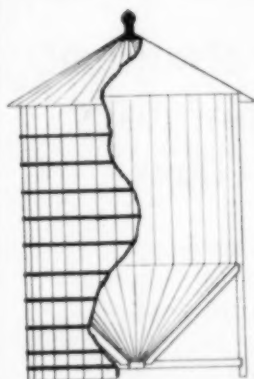
**Challenge Company, 162 River St., Batavia, Ill.**

## "Crown" Brand CHEMICAL STONEWARE

For the Chemical and allied industries. Used by the largest companies in the field.

Send for our new catalogue

**The Robinson Clay Product Company, Akron, O.**



## Tanks, Towers and Water Supply Systems for Every Purpose

If you need tanks of wood or metal, towers or a water supply system, regardless of conditions or the purposes for which they are intended, we can satisfy you.

We have filled over 17,000 such orders and our engineering department will be glad to help you solve your problems.

Write us telling your needs and ask for our special circular No. 57.

**The Baltimore Company, Baltimore, Md.**

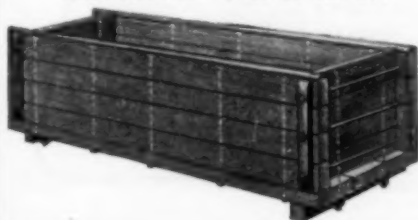


## Kalamazoo Tanks for High Quality

We have learned the ART of Tank Manufacture from fifty years of actual experience. Choicest materials used and skillful workmanship throughout.

We will build you what you need in our line.

When it comes to large work, the following list of "head in each end" Tanks recently built will show what we can do:



- 4 Tanks 24 ft. diam. by 24 ft. stave.
- 4 Tanks 28 ft. diam. by 26 ft. stave.
- Tank 32 ft diam. by 22 ft. stave.
- 2 Tanks 16 ft. diam. by 26 ft. stave.
- 2 Tanks 36 ft. diam. by 18 ft. stave.

**KALAMAZOO TANK & SILO CO.**  
MICHIGAN



MANUFACTURERS OF

## CHEMICAL EQUIPMENT

of Copper, Brass or Iron

EST. 1870 IN PHILA.

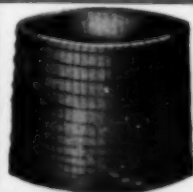
We also offer to the trade High Grade MACHINE Work, BRASS and COPPER FITTINGS as well as TANKS of Iron or Steel.

**GEORGE F. OTT CO.** Office: 213 Buttonwood St., Phila., Pa.

## EAGLE TANKS

We build everything needed by the Chemical industries in the line of tanks, vats, generators, sulphur towers, etc. Don't buy before investigating our prices.

**EAGLE TANK CO.** 2442 N. Crawford Ave.  
CHICAGO, ILL.

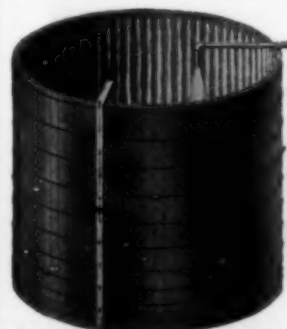


**Wood Tanks** All Sizes  
All Shapes  
Plain or Lead Lined  
of Cypress, Yellow Pine, Cedar or Oak

Wood Agitator Tanks and other "Specials" promptly delivered. Write for Catalog D.

**J. Schwarzwald & Sons, Inc.**

Established 1853  
15th and Jefferson Sts., Hoboken, N. J.



**Built the National Way  
They're 100% Satisfactory**

We are in the heart of the biggest and finest body of standing timber in the world so we get the best of materials at low cost. We know how to manufacture, and that's why you get 100% satisfaction from "NATIONAL QUALITY" Tanks and Pipe.

Write for prices to-day.

Information and Catalogs on Request

**NATIONAL TANK & PIPE COMPANY**  
275-T Oak Street PORTLAND, ORE.

# FRY QUALITY

Resistance

The Practical  
Laboratory  
Glass

A glass of high thermal endurance, minimum solubility and uniform composition. It measures up to the Fry Standard of quality which is the best made.

The full resistant power of the glass is scientifically developed. Skilled workmanship and rigid inspection insure excellence.

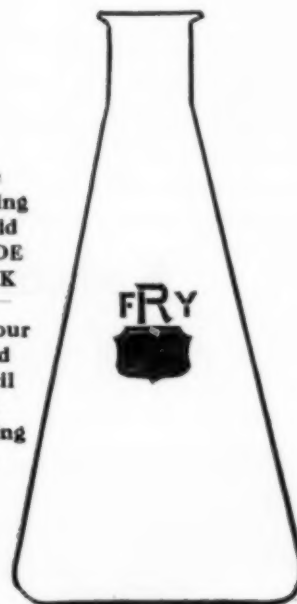
*IT IS RIGHT IN ALL WAYS*

Distributed by  
Laboratory Supply Houses

**H. C. Fry Glass Company**  
Rochester, Pa.

See  
Marking  
Shield  
TRADE  
MARK

Use your  
lead  
pencil  
for  
recording  
data



The quickest and simplest  
Crucible Holder

**ESCO**  
Gooch Crucible Holder



Busy chemists will appreciate the unique design. Hot acid solutions can be filtered without danger of contamination, as the rubber plug is completely lined inside with a bell-shaped glass covering. The taper of the plug is so designed as to fit flasks of various sized necks. One complete Holder will take the place of the usual carbon tube, rubber tubing and stopper. Try a sample.



**Eberbach & Son Company**  
Ann Arbor, Michigan

*THIS*  
**AINSWORTH**  
TYPE Q  
**Analytical Balance**



With Improved Multiple Rider Carrier is used in the foremost laboratories where accuracy combined with speed are the prime requisites.

*Send for Catalog A-4*

Covering our complete line of Assay and Analytical Balances and Weights.

**Wm. Ainsworth & Sons, DENVER COLO.**



# AMERICAN PLATINUM WORKS

225-231 New Jersey Railroad Ave.

NEWARK, N. J.

## Superior Platinum Ware



We justly pride ourselves in the **SUPERIOR QUALITY** of **PLATINUM WARE** turned out of our factory. The fabrication of which is surrounded by so many safeguards and each detail is so carefully worked out that our patrons derive complete satisfaction from its use.

Logic enough why our ware should prove so attractive to the chemical world.

Convince yourself by placing your next order with us.

Let us send you our descriptive catalogue illustrating the complete line of ware we manufacture.

Old platinum ware repaired, purchased or exchanged against new apparatus.

NEW YORK OFFICE: **CHARLES ENGELHARD**, 30 CHURCH ST.

Fully satisfies the demand for American Made Chemical Glassware which will equal that formerly imported from Europe

**Insolo** Beakers and  
Flasks  
Volumetric Flasks and  
Pipettes

BLOWING GRINDING ENGRAVING  
EXPERIMENTAL WORK

Glass Tubing and connecting tubes for nitric acid plants. We specialize in high-class glass work, and carry a well assorted stock of Laboratory Glassware and Supplies.

**The International Glass  
Company**

Caloris Dept.

Millville, N. J.

## Nickel Platinum CRUCIBLES



Made of Pure Nickel or Platinum, with covers. Those of Nickel best adapted to alkali solutions, where platinum crucibles might be damaged. Far superior to any foreign makes obtainable.

## DISHES

Glass evaporating dishes with lip; unexcelled for cement analysis. Ask for catalog and price list of laboratory supplies.

**GRIEBEL INSTRUMENT CO.**  
CARBONDALE, PA.

## TEMPERATURE REGULATOR

**S**

Can not feed  
too much

cientific

**A**

Can not feed  
too little

utomatic

**R**

Maintains the  
temperature at the  
Point you set it

apid

**C**

Supplies its own  
motive power and  
costs nothing to  
operate

ontrol

**O**

Simple  
unfailing  
and  
durable

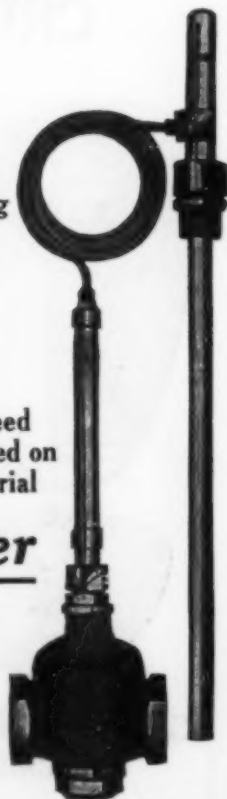
f

Guaranteed  
and supplied on  
30 days trial

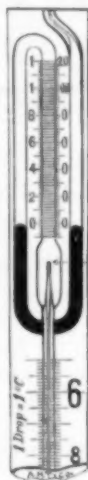
Steam, Water  
or Gas

**Sarco Company, Inc.**

WOOLWORTH BLDG., NEW YORK  
CHICAGO, MONADNOCK BLOCK



## BECKMANN THERMOMETERS



Of American make and equal in accuracy and workmanship to those heretofore imported.

**48288A. Thermometer, Beckmann.** With scale held in place by glass sealing; with auxiliary scale with range from—10 to 120° C. in 2° divisions under reservoir; for use by either boiling point or freezing point method; range 5° or 6° C. divided by 1/100th degrees. Highly recommended and widely used in calorimetry.

**Without Certificate . . \$18.00 net**

**With U. S. Bureau of Standards Certificate \$33.00 net**

**48292A. Thermometer, Beckmann,** similar to No. 48288A as to range and accuracy, but with improved adjustment of auxiliary scale by means of controlled mercury drops instead of by tapping. To accomplish this a short capillary "A" is introduced in the lower part of the reservoir. The opening of this capillary is adjusted for delivering a controlled drop of mercury of definite equivalent in degrees C., which information is engraved on the scale of each thermometer as, for instance, "1 drop = 1° c." This arrangement prevents the dropping down of the mercury when an upward movement is necessary, and superfluous mercury may be transferred to the two arms at the side of the reservoir by simply inclining the thermometer.

**Without Certificate . . \$30.00 net**

**With U. S. Bureau of Standards Certificate \$45.00 net**

*Prices subject to change without notice*

**ARTHUR H. THOMAS CO.**

IMPORTERS—DEALERS—EXPORTERS

**LABORATORY APPARATUS AND REAGENTS**

West Washington Square

Philadelphia, Pa.

## Young's Gravitometer for Solids



Young's Gravitometer for Solids is a direct reading specific gravity balance with a range from 0.85 to 10.00. It is accurate to the second decimal place between 0.85 and 2.00. Many rubber manufacturers are using these gravimeters for determining the specific gravity of their products. No weights or calculations are required, and the operation is extremely simple.

**EIMER & AMEND**

Founded 1851

Headquarters for Laboratory Supplies and  
Industrial Testing Apparatus

Pittsburgh, Pa.

New York City

Ottawa, Canada



# Vitreosil

# Pure Silica

## Critical Temperatures

Devitrification Point	above 1100° C.
Softening Point approximately	1400° C.
Melting Point approximately	1750° C.

Vitreosil is not recommended for continuous work at temperatures in excess of 1100° C. although on intermittent work at much higher temperatures it gives satisfactory results.

*Send for Data and Prices*

### THE THERMAL SYNDICATE LTD

Chemists' Building, 50 East 41st Street

NEW YORK CITY



# Palau

Reg. U. S. Pat. Office

## Laboratory Utensils

### A Special Rare Metal Alloy for Replacing Platinum

The cost of Palau Ware is approximately half the cost of Platinum Ware.

Thoroughly tried and tested in laboratory routine, and for laboratory utensils proved superior to Platinum.

Made in all standard shapes and sizes.

Catalog, also Bureau of Standards Report on Palau Ware, sent on request by your dealer.

Eimer & Amend, New York  
 Arthur H. Thomas Co., Philadelphia  
 E. H. Sargent & Co., Chicago  
 Central Scientific Co., Chicago  
 The Braun Corporation, Los Angeles  
 Braun-Knecht-Heimann Co., San Francisco  
 Lymans, Limited, Montreal  
 B. C. Assay & Chemical Supply Co.,  
 Vancouver, B. C.



## You are paying for the Marchant Calculator whether you buy it or not

If you need a thing, you pay for it, even though you do not have it.

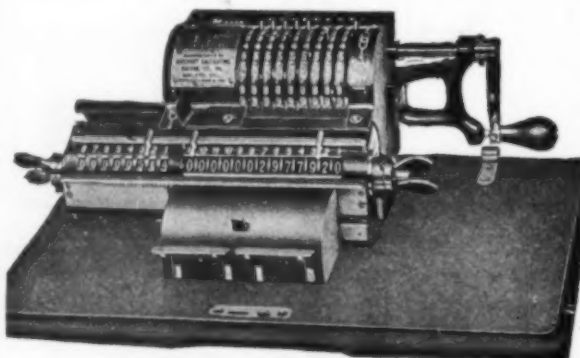
Why not possess it and draw the dividends from its use?

The Marchant is

### A quick, infallible mechanical brain

It replaces the sluggish and unreliable human brain in all calculations—addition, multiplication, subtraction and division.

Use your accountants' brains for *thinking* only—do not saddle them with work that the MARCHANT can do better and in quarter the time, and automatically prove at the same operation.



By solving examples like the following in 6 seconds, it pays for itself several times a year:

$$\text{Specific gravity} = \frac{145.88}{145.88 - 42.5} \text{ for liquids heavier than water.}$$

$$\text{sp. gr.} = \frac{145.88}{145.88 - 42.5} = 1.4111$$

Could we show greater faith in the  
MARCHANT than our willingness  
to have you

**TRY IT** absolutely  
without cost?

We will place a MARCHANT in your office, instruct you how to use it, and allow it to help you in your work, absolutely free and without obligation. Send the coupon below for details.

MARCHANT CALCULATING MACHINE CO.  
Federal Realty Bldg., Oakland, Cal.

Gentlemen:

Please send me your Booklet M3-15 about the Marchant Calculating Machine.

Firm .....

Name .....

Address .....

My business is .....

## Gold Medal Award



Panama-Pacific  
Exposition  
for

## THWING HIGH RESISTANCE MULTIPLE RECORD PYROMETERS

Their Merits are Vouched for by  
Hundreds of Satisfied Users

Ask for our New General Catalog No. 8

**Thwing Instrument Co.**  
3340 Lancaster Ave. Philadelphia, Pa.

## In the Leeds & Northrup Potentiometer System of Pyrometry

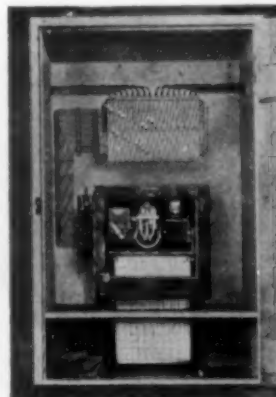
precision and sensitivity are combined, the effects of resistance in galvanometers, lead wires and thermocouple being eliminated.

The lead wires may be long or short and the thermocouple itself thin or thick, or partially or wholly immersed, but so long as there is actual contact between the thermocouple metals, the correct electromotive force and the correct temperature will be read.

Inexpensive and readily replaced base metals can be used instead of highly expensive platinum. By making the lead wires of the same metals as the thermocouple, the "cold" junction is brought back to the potentiometer, where its effects are readily compensated for automatically. No steam

box, ice box or other accessories for cold-end compensation are required.

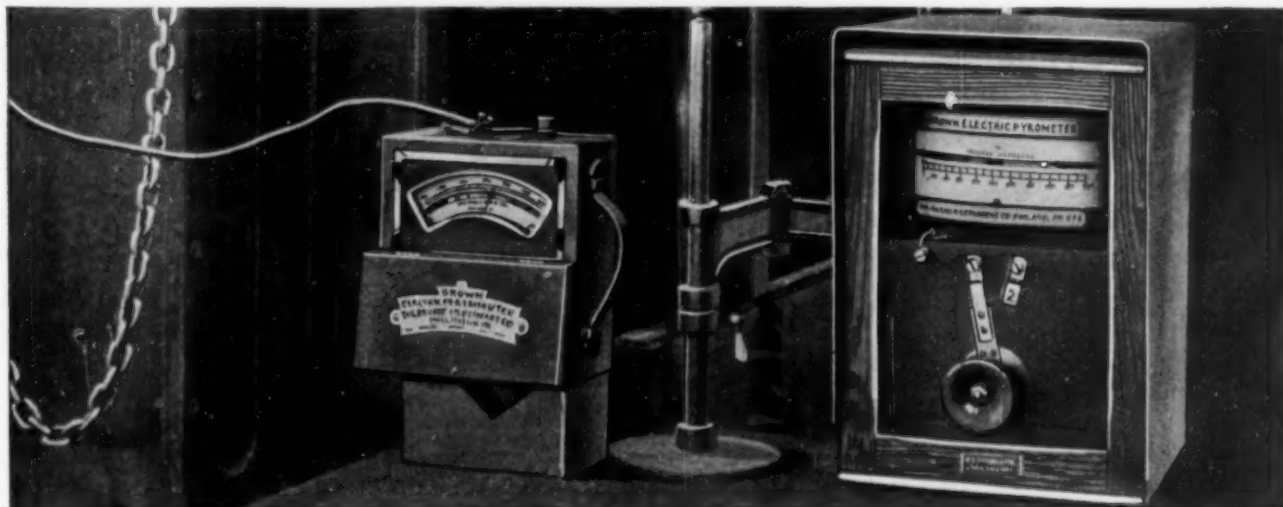
State number and type of furnaces in use and present methods of temperature control, and ask for our new Bulletin M. 875.



### The Leeds & Northrup Co.

Makers of Electrical Measuring Instruments, including indicating and recording thermocouple and resistance pyrometers, condensers, galvanometers, Wheatstone bridges, testing sets, etc.

4921 Stenton Avenue  
Philadelphia, Pa.



## What Is Your Heat-Treating Problem? Put It Up to Browns


The above photograph shows a corner of the big Gray & Davis plant and their Brown Pyrometers. Maybe you use a G. & D. lighting system on your car.

If the small parts of an automobile lighting system can be so well heat-treated with Browns that they are little affected by excessive wear and the jolts and jars of rough roads isn't the recommendation of this big firm worth something to you?

There's a plant in your line using a Brown Equipment that will tell you how successful they are. Over 6000 other Brown Boosters are glad to put in a good word.

Write to the Brown Instrument Company, Philadelphia, or one of their offices in New York, Pittsburgh, Detroit or Chicago for full information now.

# BROWN PYROMETERS



## Pyrometry

### THE INDESPENSABLE !!

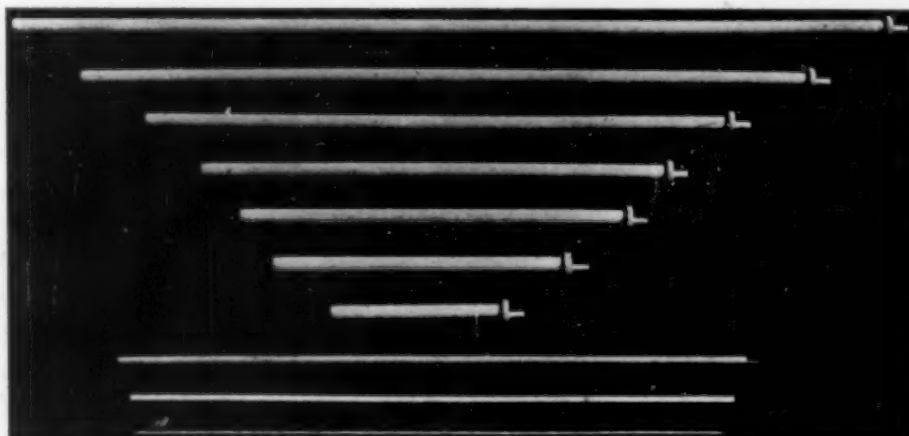
Pyrometry has safeguarded production in all great plants where high temperature is a vital factor. In metallurgical, ceramic and a host of other fields, by pyrometers, precision of results are rendered possible; absolute information available; the records of yesterday for today's guidance; standards of efficiency raised. Proud are we of the part *Tycos* Instruments have played in the upbuilding of great industries, and further to share with our worthy contemporaries the honor accompanying such pyrometer achievements.

## *Tycos* Pyrometers

possess the many dependable qualities desired, meeting in abundant measure your expectations. In short the endorsement of *Tycos*; the preference expressed have built up our great factories, still growing—overwhelming endorsement indeed.

To those unacquainted with us we seek acquaintance, be it through our literature, our advisory service, or a personal call. Command us.

*The Taylor-Cambridge Division*  
**Taylor Instrument Companies**  
Rochester, N.Y.



## **"USALITE" PYROMETER PROTECTION TUBES**

A neutral refractory porcelain. Superior to all others.  
Possess remarkable mechanical strength. Will neither bend nor corrode.  
Are positively impermeable to gases at highest temperatures.

Manufactured by

**The Stupakoff Laboratories** 6625-6639 Hamilton Ave.,  
Pittsburg, Pa.

## **The Roessler & Hasslacher Chemical Co.**

*Manufacturing and Importing Chemists*

**Chemicals for All Industries**

100 William Street, New York

**BRANCHES:**

Boston  
Cleveland  
Philadelphia

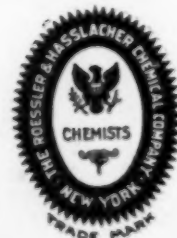
Chicago  
Kansas City  
St. Louis

Cincinnati  
San Francisco  
New Orleans

**WORKS:**

Perth Amboy, N. J.

Niagara Falls, N. Y.



### **Gold Medal Award**

**Panama-Pacific International Exposition, San Francisco, 1915**

**"SODIUM CYANIDE"**

used in solution for the extraction of precious metals

**"CYANEGG"**

**"CYANOGRAN"**

for fumigation in horticulture (granular), for heat treatment and case hardening

### **Other Gold Medal Awards**

Chicago, 1894

Omaha, 1898

Buffalo, 1901

**Grand Prize—St. Louis, 1904**

**Metal Cyanides and Trisalyts for Electro Plating**





A STUDEBAKER CORPORATION LABORATORY

## HOSKINS TUBE FURNACES

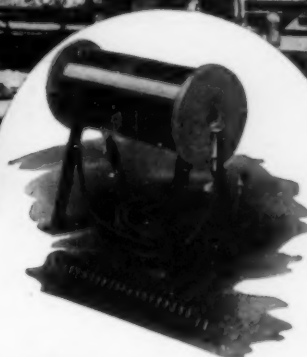
FOR CARBON COMBUSTIONS

The laboratories of the largest industrial plants in the country are equipped with these Electric Furnaces. The temperature is easily controlled and doesn't fluctuate. The tube is uniformly heated throughout its length.

Maximum working temperature is 1100° C. The heating element is of heavy "Chromel" wire and can be readily replaced in a few minutes by the operator.

### Typical Users

Carnegie Steel Company  
Midvale Steel Company  
Mesta Machine Company  
Timken Roller Bearing Co.  
Nash Motors Company  
U. S. Alloys Corporation  
American Steel Foundries



*Chromel*

RENEWABLE  
HEATING UNIT

### Dealers

E. H. Sargent & Co., Chicago.  
Scientific Materials Co., Pittsburgh  
Rausch & Lomb Optical Co., Rochester  
Central Scientific Co., Chicago  
Henry Heil Chemical Co., St. Louis.  
L. E. Knott Apparatus Co., Cambridge, Mass.  
A. H. Thomas Co., Philadelphia, Pa.  
Palo Company, New York

**HOSKINS MANUFACTURING CO.**  
457 Lawton Avenue, Detroit Michigan

### Branch Offices

Otis Bldg.,  
CHICAGO

Grand Central Terminal  
NEW YORK CITY

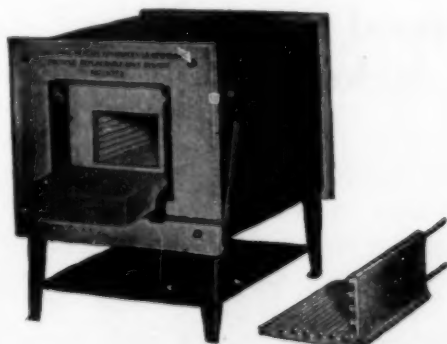
Oliver Bldg.,  
PITTSBURGH

Tremont Bldg.,  
BOSTON

Canadian Hoskins, Ltd.,  
WALKERVILLE, ONT.

## 250 PERCENT INCREASE IN SALES IN 17 MONTHS

Definitely proves COMPLETE SATISFACTION to all users of  
MULTIPLE REPLACEABLE UNIT ELECTRIC FURNACES  
AND  
MULTIPLE UNIT HOT PLATES



MUFFLE TYPE—HAS UNITS REVERSIBLE FOR  
OPEN GROOVE OR MUFFLE FACE ASSEMBLY

1914 MODELS  
MADE  
IN  
MUFFLE,  
TUBE  
AND  
CRUCIBLE  
TYPES



COMBUSTION TUBE TYPE—GAVE 1576  
HOURS IN LIFE TEST AT 1900° F.

CATALOGS UPON REQUEST

MULTIPLE UNIT FURNACES  
CARRIED IN STOCK BY

ARTHUR H. THOMAS CO., Philadelphia  
EIMER & AMEND, Pittsburgh  
E. H. SARGENT & CO., Chicago  
EIMER & AMEND, New York  
LYMANS, Ltd., Montreal  
BRAUN-KNECHT-HEIMANN CO., San Francisco  
EIMER & AMEND, Ottawa  
THE BRAUN CORPORATION, Los Angeles

**ELECTRIC HEATING APPARATUS CO.**  
MULTIPLE UNIT FURNACES & HEATING APPLIANCES

GENERAL OFFICE & WORKS:  
121-123 Sussex Ave., Newark, N. J.  
Branch Office: 25 Church Street

## Metal Testing Instruments

### The Brinell Meter

for determining the hardness of metals and metal products

### The Erichsen Machine

for testing metal sheets, strips, and wires

*Write for Catalogues*  
**Herman A. Holz**  
**48 Church St. N.Y.**

## For Hardness Testing in shop and laboratory use the

### Standard Scleroscope

Universally adopted; direct reading; inexpensive, and the only instrument that agrees with others of its kind in all parts of the World, thus solving problems of ordering materials to specifications.  
**BOOKLET FREE.**

### Heat Indication

by optical means is fast being recognized as the correct thing. The PYROSCOPE has solved the problem. Perfect constancy, inexpensive, no electricity used. Built to stand rough usage and upon common-sense lines. Used by the Government and best firms.



THE PYROSCOPE

Agents in all foreign Countries



(Set)

**SHORE INSTRUMENT & MFG. CO.** **THE SCLEROSCOPE**  
555-7 W. 22nd St., New York

## PYROLECTRIC INSTRUMENT CO.

148 East State Street Trenton, N. J.

E. F. NORTHRUP, President and Technical Adviser.

### Specialists in temperature-measuring apparatus

Our NORTHRUP PYROVOLTER is a new instrument with a new principle for the very accurate measurement of temperature with either base metal or noble metal thermo-couples. It reads electromotive force like a potentiometer, but deflects like a voltmeter. Send for our circular, "NORTHRUP PYROVOLTER."

## PLATINUM WARE

For All Purposes

Crucibles Wire Dishes Foil Electrodes

**J. Bishop & Co., Platinum Works, Malvern, Pa.**  
Refiners of Platinum, Gold and Silver

# A New Adiabatic Calorimeter

## The Emerson Fuel Calorimeter Can Now Be Furnished Equipped with the Daniels Adiabatic Jacket

The Daniels Adiabatic Jacket as perfected by Mr. Farrington Daniels eliminates the radiations from the calorimeter during a heat of combustion test by raising the temperature of the jacket at a rate equal to the rate of the rise in temperature in the calorimeter.

This type of jacket prevents exchange of heat between the jacket and the calorimeter bucket and is of durable construction, with no glass or other fragile parts.

The Daniels Jacket operates only on alternating current. Write us at

**EMERSON APPARATUS CO., 251 Causeway St., Boston, Mass.**



## Instantly finds the proper hardening point of steels



Patent  
applied  
for

**Price**  
**Decalescence**  
**Point Finder**  
**\$25.00**  
**Complete with**  
**Re-Magnetizer**  
**\$50.00**

**S. A. S.**  
**DECALESCENCE**  
**POINT FINDER**

Consists of a specially designed magnet, carefully balanced and highly sensitive. Accurately determines the critical point at which steel becomes non-magnetic when the transformation range has been passed and it is ready for hardening.

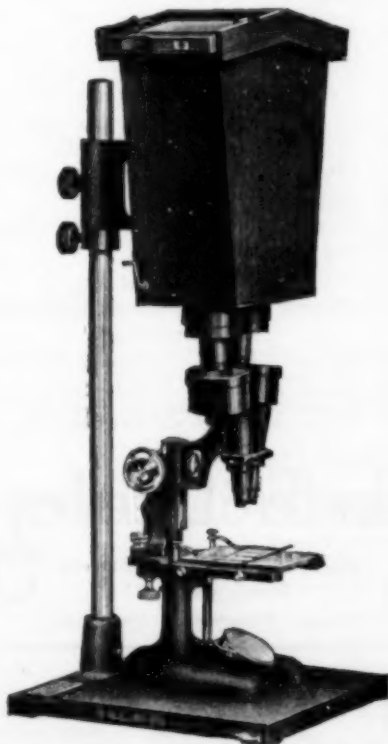
The magnetic method is recognized as very valuable in determining this critical point. The operator applies the S. A. S. Decalescence Point Finder to large or small furnaces, or to open forges. It is not necessary to take the piece from the furnace, as the tool is suspended upon an extension arm over the work in furnace.

S. A. S. RE-MAGNETIZER—An efficient tool for re-magnetizing our Decalescence Point Finder by a one minute application. Fool-proof and substantially built. Use on D. C. only 110V-150V.

Slocum, Avram & Slocum Laboratories, Inc., 534 W. 21st St., New York



## Stereoscopic Camera for Binocular Microscope



This new photomicrographic camera is a natural development, inspired by the favor accorded our Binocular Microscope KA. It makes a photomicrograph with the same superior characteristics as those obtained visually with our binocular microscope itself—proper perspective, perception of depth, form and solidity and an image erect and unreversed.

Most striking results are obtained with this instrument in many classes of work. It admits of a wide range of applications in educational research or industrial laboratories.

*Write for descriptive circular.*

**Bausch & Lomb Optical Co.**

NEW YORK WASHINGTON CHICAGO SAN FRANCISCO  
LONDON ROCHESTER, N.Y. FRANKFORT

*Leading American Makers of Microscopes, Projection and Photomicrographic Apparatus, Photographic and Ophthalmic Lenses, Binoculars and other High-Grade Optical and Laboratory Equipment.*

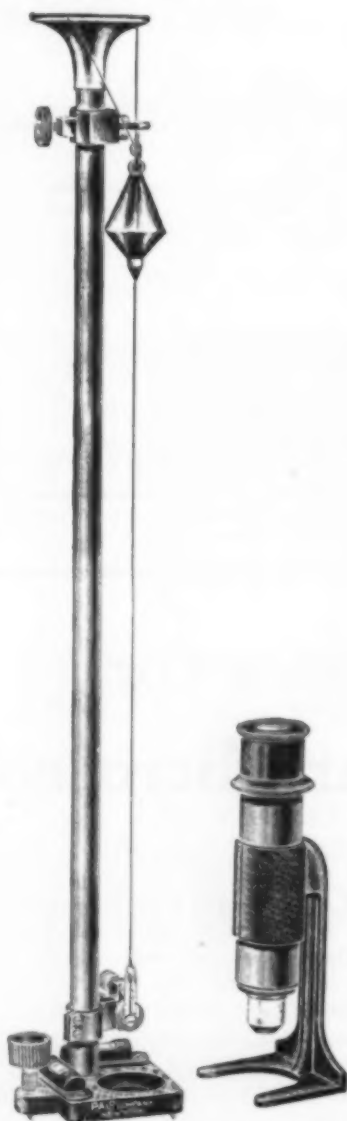
*Grand Prize—Panama-Pacific Exposition*



# WALDO Hardness Tester!

(Patented)

For Testing Hardness of Metal under  
conditions of service.



Made by

**PALO COMPANY**  
Laboratory Supplies and Chemicals  
90-94 Maiden Lane, New York

Write for Booklet

# Where Temperature Is to Be Recorded Accurately—

## More of Our Line

"CRESCENT"



THERMOMETERS

"COLUMBIA"



RECORDING GAUGE

GAUGES



TACHOMETER



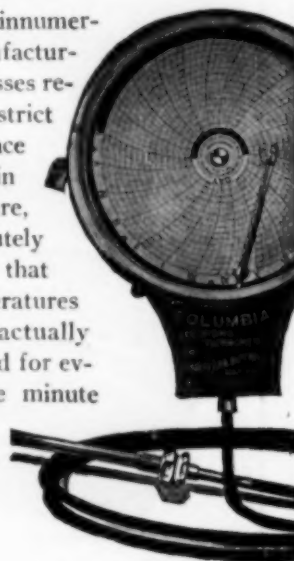
HAND



TACHOMETER

SIPHON  
OR U  
GAUGE

In those innumerable manufacturing processes requiring a strict maintenance of a certain temperature, it is absolutely essential that the temperatures that are actually maintained for every single minute be accurately recorded.



# COLUMBIA SCHAEFFER & BUDENBERG Recording Thermometers

furnish accurate records of all temperatures up to 1000° F. The "Columbia" charts, with their bright red mechanically traced record lines, give you a knowledge of actual results that is positively vital to the quality of your product or the efficiency of the process.

**Mercury Actuated**—thus sensitive and accurate.

**Steel Construction**—hence rugged and durable.

Ask for Catalog  
R-300, which tells all about the  
"Columbia."

Also other forms of Industrial Thermometers, including the "Reform" Mercury Actuated Dial Thermometer, Glass Thermometers, etc. Electric Pyrometers for temperatures over 1000° Fahrenheit.

THE  
**Schaeffer & Budenberg**  
MFG. CO.  
Berry and South 5th Streets  
Brooklyn, N. Y.

Chicago Philadelphia Pittsburgh



DIFFERENTIAL DRAFT GAUGE

ALSO

Other Instruments identical or allied  
in their functions to those outlined.



HEADQUARTERS FOR MINE-MILL AND SMELTER EQUIPMENT

For Flexibility and Speed in Reduction:

# The McCool Pulverizer

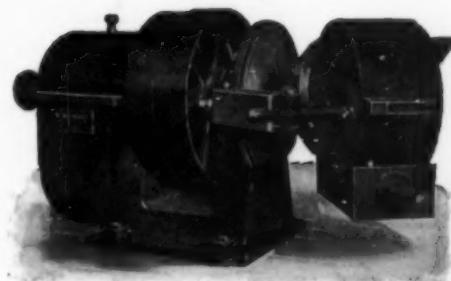
Every sampling and assay department should be supplied with these convenient little machines. Users declare that the McCool Pulverizer meets their requirements more perfectly than any piece of apparatus they have ever used for grinding ore samples and the preparation of control pulps.

Combines great capacity with simplicity and durability. Grinding is done between one stationary disc and one having a double rotation. This arrangement keeps the discs smooth and serviceable in constant use.

Any desired fineness of mesh is secured by turning a hand wheel while pulverizer is running. Machine is opened for cleaning and removal of pulp in one operation.

Made in two sizes, for different capacities.

Write for booklet. Also ask for "Success in Purchasing."



## THE MINE AND SMELTER SUPPLY COMPANY

A SERVICE STATION WITHIN REACH OF YOU

DENVER

SALT LAKE CITY

EL PASO

NEW YORK OFFICE - 42 BROADWAY

## MAGNESIUM

The lightest commercial metal. One-third lighter than aluminum.

\$2.00 per lb., Niagara Falls, N. Y., Liberal discounts for large quantities.

Magnesium bars, 99% pure. Magnesium—copper alloys.

Magnesium—aluminum alloys. Calcium—copper alloys.

## AMERICAN MAGNESIUM CORPORATION

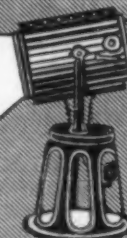
Niagara Falls, New York

"We are very well  
pleased with results"—

**300 TANKS Cheap**  
Taken From Tank Cars  
Thoroughly Overhauled, Tested and Painted.  
1—750 gallon rectangular open top lead lined.  
2—885 gallon vertical cylindrical open top, lead lined.  
2—2000 gallon vertical cylindrical closed top, lead lined.  
Universal Iron & Supply Co., St. Louis, Mo.  
TANK SPECIALISTS

this was the ad. which they inserted in the

**Searchlight Section—**



**Searchlight  
Advertisements  
DO PULL!**

# MERCK'S BLUE LABEL REAGENTS

are tested according to the book of standards, "Chemical Reagents: Their Purity and Tests." The analysis is on every label. Instruct your dealer to send you Merck's "blue label" goods only.



Do You Harden Steel?

← **SEND FOR THIS NOW—YOU NEED IT**

*this free pamphlet by Carl Nehls, Metallurgist, will help you*

It tells briefly yet technically how many companies have practically eliminated the waste pile by the use of "SENTINEL" Pyrometer Pellets, indicating *accurately* without the use of electrical pyrometers when the proper temperature has been reached. "How to Harden Steel" also gives valuable information about what happens to the metallic structure when steel is hardened—gives best hardening temperatures, and tells how they may be ascertained. Send now—free to all interested.

**Carl Nehls Alloy Co.**

DETROIT,  
MICH.

N. Y. Agents: Palo Co.,  
92 Maiden Lane

**FOXBORO**  
TRADE MARK



INDICATING  
and  
RECORDING  
INSTRUMENTS

for  
Pressure  
Temperature  
Speed, Time  
and Flow are  
**UNEQUALLED**

Send for Bulletin AM-96

THE FOXBORO CO.  
Foxboro, Mass.

New York  
50 Church St.  
St. Louis  
1984 Ry. Ex. Bldg.

Chicago  
1363 Monadnock Bldg.  
Birmingham  
729 Brown Marx Bldg.

Pittsburgh  
Diamond Bank Bldg.  
San Francisco  
461 Market St.

## Hamburg Riveted Steel Tanks

For Air, Oil, Storage and Pressure  
3-16 in. to 1/2 in. metal

**Hamburg Boiler Works**  
Hamburg, Berks Co., Pa.

## Packingless Centrifugal Pumps and Valves

THE CHEMICAL PUMP & VALVE COMPANY  
Perth Amboy, N. J.

## Scientia Calorimeters

and other High-Grade

Physical and Chemical Apparatus

Universal Laboratory Supports—Laboratory Spectrometers—Spectrometers—Cathetometers—High-Grade Thermometers—Laboratory Balances, Weights, etc., etc.

*A line to us brings Catalogs.  
We can save you money.*

**Wm. Gaertner & Co.**

5345-49 Lake Ave., Chicago



No. 2329

**BOOTS**  
SPECIFIC GRAVITY  
BOTTLES  
Double Wall  
With Vacuum  
25 cc 50 cc

**Schaar  
&  
Company**  
Chemists' Supplies  
Chicago

Little "Want Ads" in the  
Searchlight Section  
bring BIG results



## The subscription was discontinued because a "Want" Advertisement brought results

Editor—"We are sorry to lose your subscription, Mr. Jackson. What's the matter? Don't you like our politics?"

Mistah Jackson—"Tain't that, sah; 'tain't dat. Mah wife jes' been an' dun landed a job o' wuk for me by advertisin' in youh darned ole papah."

If you're looking for a "job o' wuk" in the metallurgical or chemical field—

—if you're looking for a competent man who will be able to handle a big or a little "job o' wuk" and who will bring RESULTS—

—there is no more efficient or economical method of securing either than the insertion of a card in the

### SEARCHLIGHT SECTION

The cost of these advertisements is small, but the results are usually prompt and satisfactory. Try an ad in our next issue.

Metallurgical and Chemical Engineering  
239 West 39th Street, New York

## DAIGGER

Chicago, Ill.  
LABORATORY SUPPLIES  
AND CHEMICALS.

Hoyt's Electrical Penetrometer—A quick, safe, dependable tester of Asphalts, Road Oils and Tars. Write for Booklet.

We can make immediate shipment from our complete stock of laboratory supplies and chemicals.

A. Daigger & Co., 54 W. Kinzie St., Chicago

## E. H. SARGENT & CO.

Importers, makers, dealers in Chemicals and Chemical Apparatus of High Grade only

125-127 W. Lake St. CHICAGO, ILL.

## A Laboratory Centrifugal

The S. & U. Centrifugal meets the varied requirements of the busy chemist. It is easy to operate, safe, durable, convenient—efficient in every way.

SCHAUM & UHLINGER, Inc.  
Glenwood Ave. and Second St., Philadelphia, U. S. A.

## For Every Laboratory Filtering Need —



## WHATMAN

High Grade FILTER PAPERS

ARE you using the Whatman grade best suited to your work? If in doubt, our Service Department will gladly assist you in the selection of the *exact* grade you need.

### Qualitative Papers

- No. 1 For general work.
- No. 2 For fine precipitates. Very rapid.
- No. 3 Heavy. For the finest precipitates.
- No. 4 For gelatinous and large particle precipitates. Extremely rapid.

### Single Acid Washed

- No. 30 For general Quantitative work, where the lowest ash is not necessary.
- No. 31 For gelatinous and large particle (not fine) precipitates. *The most rapid Filter paper made.*

### Double Acid Washed

- No. 40 For general Quantitative work.
- No. 41 Very rapid. Not for use with fine precipitates.
- No. 42 For extremely fine precipitates. For use with or without vacuum.
- No. 44 Lower ash than any above mentioned. For the most exacting analyses.

All sizes and grades of Whatman Filter Papers are packed in sealed boxes to prevent contamination

Your usual Supply House will give you full information and samples

H. REEVE ANGEL & CO., Inc.  
120 Liberty Street, New York, N. Y.

Sole Representatives for the United States and Canada

# PROFESSIONAL DIRECTORY

CHEMICAL ENGINEERS METALLURGISTS CHEMISTS ENGINEERS LABORATORIES ETC.

**W. G. ABBOTT, Jr.**  
Research Engineer

Development of Inventions, Special Machinery and Industrial Processes  
Laboratory, WILTON, N. H.

**PHILIP L. DAVIS**  
Consulting Chemist and Chemical Engineer

Complete Chemical Plants furnished.  
Laboratory and Experimental Plant at TOMS RIVER, N. J.  
NEW YORK OFFICE, 120 Broadway

**N. L. HEINZ**  
Consulting Engineer

Metallurgy of Zinc and Manufacture of Sulphuric Acid.  
1519 Oliver Bldg.,  
PITTSBURGH, PA.

**JOHN F. ABERNETHY**

Lead Burning      Lead Lined Tanks  
Lead Work of every description  
703 Myrtle Ave., BROOKLYN, N. Y.

**ELECTRICAL TESTING LABORATORIES**

Tests  
80th St. and East End Ave.,  
NEW YORK, N. Y.

**HERCULES ENGINEERING CORPORATION**

Complete Chemical and Electrochemical Plants  
Reports, Plans, Specifications and Purchasing  
501 Fifth Avenue  
NEW YORK CITY

**JOHN H. BANKS**

Formerly of Ricketts & Banks  
Mining Engineer and Metallurgist  
Special attention to problems in ore treatment—Complete Laboratories—Assays and Analyses.  
61 Broadway, NEW YORK

**FALKENBURG & LAUCKS**

Chemists  
Sampling and Analysis  
Inspection  
All materials at  
PACIFIC PORTS  
W. U. Code,      Seattle, Wash.

**CARL HERING**  
Consulting Electrical Engineer

Tests, Examinations, Researches, Reports Patent Litigation, Etc.  
Electrical Furnaces, Thermal Engineering, Electrolytic Corrosion, Electro-Chemistry  
210 S. 13th St., PHILA., PA.

**J. W. Beckman      H. E. Linden**  
Beckman & Linden Engineering Corporation  
Chemists      Engineers

Examinations and reports of properties and the development of hydroelectric projects together with adjacent raw materials. Financing and management of industrial enterprises. Research work undertaken.  
604 Balboa Bldg., San Francisco, Cal.

**THE FITZGERALD LABORATORIES, INC.**

F. A. J. Fitzgerald, Pres.  
NIAGARA FALLS, N. Y.  
Electric furnace processes and inventions  
—Expert advice regarding design and construction of commercial plants, heat insulation and refractories.

**MILTON HERSEY CO., LTD.**

Industrial Chemists, Inspectors and Engineers  
Analytical and Assay Work.  
Steel, Asphalt, Cement Tests.  
Research and Process Development.  
Reasonable Rates.      Prompt Service.  
198 BROADWAY, NEW YORK  
Phone: Cortlandt 515

**GEORGE HILLARD BENJAMIN**  
Industrial Engineer

Patents and Patent Law  
66 Broadway,  
NEW YORK CITY, N. Y.

**A. B. FOSTER**  
M. S. in Chemistry  
Chemical, Process & Composition Patents—Soliciting, searches, opinions, validity, etc.  
Ex-Examiner—Chemical Division  
Patent Office  
527 Victor Building,  
WASHINGTON, D. C.

**HOWARD TESTING LABORATORIES**

Physical Testing and Analysis  
Iron and Steel  
Alloy steels, alloys, foundry products and supplies—Prompt service—Operate day and night.  
Bell Phone 1000  
LOCKPORT, N. Y.

**BOOTH, GARRETT & BLAIR**  
Metallurgical Chemists

Established 1856  
Analysis of special steels, ores and minerals. Water analysis, bacteriological and sanitary.  
404-6 Locust Street,  
PHILADELPHIA, PA.

**EDWARD H. FRENCH & CO.**  
Consulting Chemical Engineers

Plant design, Construction and Improvement. Process investigation. Experienced in refining organic chemicals. Coal tar products, wood distillation, acetic acid, acetone, turpentines, petroleum, bromine, pigments, insecticides, flotation oils.  
606 Brunson Bldg., COLUMBUS, OHIO

Robert W. Hunt,      Jno. J. Cme.      Jas. C. Hallsted.  
D. W. McNaughton

**ROBERT W. HUNT & CO.**

Engineers      Chemists      Inspectors  
Metallurgists  
Examinations, Reports on Properties and Processes  
2200 Insurance Exchange—Chicago

**BYRNES, TOWNSEND & BRICKENSTEIN**

C. P. Townsend      J. H. Brickenstein  
Patent Lawyers  
Experts in Electricity, Metallurgy, Chemistry, Electrochemistry.  
918 F Street, Rooms 58, 59, 60, 61.  
WASHINGTON, D. C.

**GELSBEEK ENGINEERING CO.**  
Consulting Industrial and Chemical Engineers

Factory and Mill designing and construction. Drying, Heating and Evaporating Engineering. Efficiency and Cost Engineering. General Designing, Surveys and Maps. Testing Laboratories, Minerals, Ores.  
Blake McFall Bldg., PORTLAND, ORE.

**THE INSTITUTE OF INDUSTRIAL RESEARCH**  
WASHINGTON, D. C.

Divisions of Metallurgy, Paint Technology, Food and Drug Products, Roads and Pavements, Chemical Engineering. Processes developed—  
Designs, specifications and superintendence—  
Tests of materials of construction.

**Canadian Inspection and Testing Laboratories, Limited**

Consulting and Analytical Chemists  
Inspecting and Metallurgical Engineers  
Branches: Toronto, Winnipeg, Edmonton, Vancouver, New Glasgow.  
Head Office & Laboratories, Montreal, Can.  
A. Gordon Spencer, Chief Chemist

**CLAUD S. GORDON COMPANY**  
Furnace and Pyrometer Engineers

Complete line of furnaces, pyrometers and equipment. Select the equipment to fit your conditions and needs.  
646 East 75th Street, Chicago

**ISAAC H. LEVIN**

(Technical Director of Electrolytic Oxy-Hydrogen Laboratories, Inc., ELECTROLABS)  
Specialist in Electrolytic Gas Production and Synthetic Precious Stones  
RESEARCH  
15 William St.  
NEW YORK CITY

**GORHAM CROSBY**  
Attorney at Law and Solicitor of Patents

Patent applications, suits, searches, reports and opinions. Specialist in chemical process, product and apparatus cases.  
80 Maiden Lane, NEW YORK CITY

**JAMES H. GRIFFIN, B.S., LL. M.**  
Patent Lawyer

277 Broadway, NEW YORK  
Late Principal Examiner U. S. Patent Office. Member of the Bar of the U. S. Supreme Court. Specialist in Chemical, Electro-Chemical and Metallurgical Cases. Reference, Elmer & Amend, N. Y.

**Dr. CHARLES F. McKENNA**  
Consulting Chemist and Chemical Engineer

Expert in Technology and Testing of Materials  
50 Church St.,  
NEW YORK CITY

# PROFESSIONAL DIRECTORY

CHEMICAL ENGINEERS METALLURGISTS CHEMISTS ENGINEERS LABORATORIES ETC.

## OTTO MANTIUS Consulting Engineer

Chemical Plants  
Evaporators, Causticizers  
Chemical Machinery

Woolworth Bldg. NEW YORK CITY

Analyses Technical Reports Research

## BERNARD ORMONT Chemical Engineer

Design, investigation and development of  
mines and chemical plants and processes.  
Patents Chemo-legal advice

Office and laboratory  
104-106 John St., NEW YORK CITY  
Phone John 2396

## JOHN E. TEEPLE, Ph.D.

### Consulting Chemist, Chemical Engineer

Design of Chemical Plants, Investigation  
of Chemical Plants, Processes and Prop-  
ositions.

50 East 41st St., NEW YORK

## CLARENCE W. MARSH

Consulting and Chemical Engineer  
Personal constructive engineering service  
for investigation, organization, design  
and operation in the chemical industry.

Engineering Designer of the Largest  
Electrolytic Alkali Plant in the World.  
101 Park Ave., NEW YORK, N. Y.

## C. L. PARKER

Ex-Examiner Chemistry  
U. S. Patent Office

### Attorney-at-Law and Solicitor of Patents

McGill Bldg.  
WASHINGTON, D. C.

## LUDWIG A. THIELE, Ph.D.

### Chemical Engineer

Design and Construction of Chemical Plants.  
Sulphuric Acid Plants (Tangent  
System). Fertiliser Plants, Ex-  
traction Plants (volatile solvents) } Specialty  
Supervision; Investigation of Plants,  
Processes and Propositions.  
Hartman Building, COLUMBUS, OHIO

## RICHARD K. MEADE

### Chemical, Mechanical and Industrial Engineer

Chemical Plants Designed, Constructed,  
Reorganized and Operated.  
Processes Investigated.

The Law Building, Courtland St.  
BALTIMORE, MD.

## FRANCIS J. PECK & CO. Consulting Chemical Engineers

Chemical Plants designed, con-  
structed, investigated, reorgan-  
ized, and operated. Processes de-  
vised, developed and improved.

Williamson Bldg.  
CLEVELAND, OHIO

## VADNER, CHARLES S., M.Sc.,

### Engineering

### Metallurgist and Chemist

Research and Experimental Work.  
Leaching and Electrolytic Recovery of Cop-  
per, Zinc, Iron, Manganese, etc.

Address: Care 22½ W. 7th South St.  
Salt Lake City, Utah.

## MOORE & SIMONSON

Contractors of Lead Burning & Chem.  
Plumbing

133 Halsey St., BROOKLYN, N. Y.

### LEAD BURNING

Specialists in the erection of Acid Cham-  
bers, Glover & Gay Lussac Towers, Con-  
centrators & Contact Plants. Lead Burning  
for Pulp Mills, Bleacheries, Print Works,  
Electrotypers and General Chemical Ap-  
paratus of all descriptions.

## PITTSBURGH TESTING LABORATORY

Research, Physical, Analytical and  
Bacteriological Laboratories  
Design of Water Purification Plants

PITTSBURGH, PA.

James Otis Handy, Director of Laboratories.  
Howard H. Craver, Chief Chemist.

## P. A. VAN HEEDEN

### Consulting Chemist

Expert in Food Products.

Analyses—Technical Reports—Research  
Superintendence.

88 Tonnele Ave., Jersey City, N. J.

## A. H. NEY, INC.

Consulting Chemists and Chemical  
Engineers

Experts in Coal-Tar Products  
and other  
Industrial Organic Chemicals

50 Church St., NEW YORK CITY

## RICKETTS & COMPANY, Inc. Mining, Metallurgical and Chemical Engineers

Mines and properties examined—Advice  
as to development and operation—Ore treat-  
ment methods determined. Assays and  
analyses of all materials and products—  
Complete laboratories for research work.  
80 Maiden Lane NEW YORK

## JAMES P. WELLS

### Consulting Hydraulic Engineer

Specialist in the investigation of  
Hydro-electric projects particularly as to  
the amount of power available

344-345 Cutler Bldg.,  
ROCHESTER, N. Y.

## NORTHERN ENGINEERING & CONSTRUCTION CO.

Specialize in the Design and Construction  
of Sulphuric Acid Plants.

Estimates submitted on Lead Burning and  
all kinds of Chemical Construction Work.

Box 974 JOLIET, ILL.

## SAM'L P. SADTLER & SON Consulting and Research Chemists

Report on chemical and electrochemical  
processes. Analyze Industrial and Tech-  
nical Products.

Office and Laboratory  
210 S. 13th St., PHILADELPHIA, PA.  
Research Laboratory: CHESTNUT  
HILL, PA.

## THE WILL CORPORATION Industrial and Chemical Engineers

A conservative organization applying  
science with persistent energy to a prac-  
tical solution of industrial problems.

Testing Laboratories  
262 East Avenue, Rochester, N. Y.

## HAMLIN & MORRISON Analytical Chemists

Established 1892  
Forest Bldg., PHILADELPHIA, PA.

## Kenneth Despres Kahn

S. B. Mass. Inst. Tech.  
Chemical Engineer  
13496 Euclid Ave., Cleveland, Ohio

Write us for rates for cards in the  
Professional Directory. Metallur-  
gical & Chemical Engineering, 239  
West 39th St., N. Y. C.

ATTENTION ANALYSTS!

SPECIMEN  
LABEL



# SQUIBB'S REAGENTS

A new line added to our list of  
High Grade Chemicals

A TRIAL WILL CONVINCE

Send us your want list and we shall be pleased to quote  
prices

## SQUIBB'S REAGENT

### Sodium Carbonate Cryst.

$\text{Na}_2\text{CO}_3 \cdot 10 \text{H}_2\text{O}$

Contains:	In.	cent.
Chloride as Cl.....	(100 Gm.)	0.0005
Sulphate as $\text{SO}_4$ .....	(100 Gm.)	0.005
Nitrate.....	(10 Gm.)	none
Phosphate.....	(100 Gm.)	none
Ammonium Salt.....	(20 Gm.)	none
Calcium.....	(100 Gm.)	none
Magnesium as $\text{MgO}$ .....	(100 Gm.)	0.0013
Aluminum as $\text{Al}_2\text{O}_3$ .....	(100 Gm.)	0.0001
Silicate.....	(20 Gm.)	none
Iron as Fe.....	(colorimetric)	0.0004
Sodium Hydroxide.....	(20 Gm.)	none
Loss at 120°C.....		62.20

The figures in parentheses express the  
quantities taken for each estimation.

LOT 15267

E. R. SQUIBB & SONS

Manufacturing Chemists,

NEW YORK



# SEARCHLIGHT SECTION

## TANKS

### Immediate Delivery

(Subject to prior sale)

20— 4,200 gal. 8' 8" dia., 9' 6" high.

4—11,740 gal. 8' 0" dia., 30' 0" long.

4—12,000 gal. 10' 4" dia., 19' 3" long.

We also have several 4400 gal., 11,350 gal. and 15,000 gal. tanks coming through for delivery in 30, 60 and 90 days.

A large line of second-hand inspected tanks also on hand.

### Tank Equipment Co., Inc.

501 Fifth Ave.

New York City

### WE BUY SCRAP PLATINUM

or any material containing Gold, Platinum or Iridium

### WE PAY MARKET PRICES

Consignments held subject to your acceptance of our offer.

### Goldsmith Bros. Smelting & Refining Co.

Chicago, Heyworth Bldg.  
Seattle, Green Bldg.

New York, 20 John St.  
Toronto, 24 Adelaide St., W.

## New Sulphur Burners

3—9-ton Vesuvius Sulphur Burners. Excellent opportunity to secure New Burners at sacrifice.

### Dryer

1—Type W-2 Ruggles-Coles-Dryer. Absolutely perfect in all respects. Never used. Bargain.

### Tennessee Copper Co.

61 Broadway

New York, N. Y.

## WANTED

By large business organization located in New York City, the selling agency, of chemicals, dyes, intermediates or pharmaceutical preparations. Our facilities consist of warehouses, large office and sales force, laboratories and chemical staff. We have ample means and can furnish Bradstreet's, Dun's, and banking references. Only those of equal standing and capable of fulfilling any contracts entered into need reply.

Address W. 1440 (N. Y.) Met. & Chem Eng., N. Y. C.

### FOR SALE—Four 7-ton "Vesuvius" BURNERS

Very slightly used, and guaranteed to be in first-class working condition.

We said in our advertisement that this spelled "Opportunity" to some keen manufacturer. It did. You will note that we now have only four for sale.

We are receiving inquiries every day, and if you wish to capitalize this opportunity, address "Opportunity," Box 1164, Met. & Chem. Eng.

## Men are snapping up Second Hand Equipment

Now—NOW—NOW is the time to advertise YOUR Equipment—the equipment you want to SELL or the equipment you want to BUY—

Everyone is snapping up the READY DELIVERY stuff. AND DOING IT AT BIG VALUE PRICES.

BEFORE this phenomenal opportunity arrived the Searchlight Section was selling equipment and selling it QUICKLY and PROFITABLY.

*But now its value has increased by bounds and leaps—due partly to present never-to-be-duplicated conditions—*

And due logically to the Searchlight's position in the minds of the BUYING-POWERS.

The opportunity is before you.

Your market is CLAMORING to buy from you.

The Searchlight will TELL YOUR STORY for you.

Use the Searchlight—

NOW

NOW

NOW

## SEARCHLIGHT SECTION

## FOR SALE

**The Entire Plant**  
of the  
**Middlesex Chemical Co.**  
At Chester, Conn.

## Consisting of:

- 11 Car Tanks (with dome), 6' 6" in dia. x 25' long (practically new).
- 2 Shriver Filter Presses, 36" x 36", side feed.
- 2 Phenol Stills, 44" dia. x 4' 2" deep.
- 1 Jacketed Vacuum Still, 6' 6" dia. x 6' deep, with agitator and condenser tank.
- 2 Nitrating Kettles (with agitators), 4' 2" deep x 3' 8" in dia.
- 11 Cast Iron Kettles, 35" dia. x 36" deep.
- 2 Stone Pumps.
- 1 Acid Egg.
- 3 Stills, 4' 1" deep x 42" dia.
- 18 Porcelain lined Steel Tanks, 36" in dia. x 42" deep.
- 6 Steel Jacketed Plates.
- 2 Steel Jacketed Evaporators, 3' dia. x 36" deep.
- 3 Quenching or dissolving Kettles, 6' 6" dia. x 6' 6" deep.
- 7 Fusion Kettles (with agitators), all these are oil burners.
- 2 Acidulating lead lined Tanks, 3' dia. x 12' deep.
- 1 Rotary Dryer, 4' 3" dia. x 19' long, made by J. P. Devine of Buffalo, N. Y.
- 1 New Rectifying Column or Benzol Still, 32" x 26' 8" long (with still 6' 6" deep x 3' 2" in dia.).
- 2 Steel Condensers 42" in dia. x 42" deep with Iron Pipe Coil.
- 1 Galvanized Air Tank, 30" in dia. x 6' long (dished heads, 5/16" plate).
- 1 Receiving Tank, 5' dia. x 10' high.
- A lot of earthen jugs, 10, 38, 40, 50 and 79 gal. capacity.
- 1 Eureka No. 1 Crusher, made by Universal Crusher Co. of Grand Rapids, Iowa.
- 25 Galvanized Steel Drums, 110 gal. capacity.
- 60 Steel Drums, 110 gal. capacity.
- 50 Galvanized Cans, 300 pound capacity.
- 2 Centre Fudge Dryers.
- 2 Galvanized Phenol Receiving Tanks, 3' dia. x 5' long.
- Several Platform Scales.
- 4 Sulphurating Outfits (with agitators, condensers and holder tanks).
- Several Worthington Duplex Pumps.
- 1 Bud and Western Pump (made by Enterprise Mfg. Co.)
- 3 Devine Vacuum Pumps.
- 2 Draining Pans, 6½" deep, 10' wide x 15' long.
- 2 Benzol Tanks, 6' 6" dia. x 25' long.
- 1 Draining Pan, 6' 8" wide x 10' long.
- Complete Laboratory Apparatus.
- Lot of New Oak Barrels (for Picric Acid) 100 pound capacity.

**Will Sell the Plant as a  
Whole or in Part**

We think this is a great opportunity for any one contemplating going into this business, to take the plant and operate same.

It has a railroad siding and is only a few miles from the city of Hartford.

**THE PERRY, BUXTON, DOANE CO.**  
216 West First St., South Boston, Mass.

**"Service"**  
**In Securing Your  
Plant Equipment  
Quickly!**

We have for immediate shipment such apparatus as Evaporators, Kettles, Filter Presses, Vacuum Dryers, Boilers, Engines, Refrigerating Machines.

- 1—4' x 30' Steam heated rotary dryer.
- 1—6' x 60' Rotary kiln.
- 1—4' x 24' Rotary vacuum dryer.
- 1—Large vacuum drum dryer.
- 1—4' x 9' Atmospheric drum dryer.
- 1—Cylindrical vacuum shelf dryer, 100 sq. ft. shelf area.
- 1—Cylindrical vacuum shelf dryer, 200 sq. ft. shelf area.
- 1—1600 Gal. Bethlehem reducer.
- 1—1600 Gal. Buffalo reducer.
- 1—50" x 16' Tube mill.
- 2—26" x 3' Pebble mills.
- 3—100 Gal. C. I. kettles.
- 2—250 Gal. Steel jacketed kettles.
- 10—105 Gal. Stoneware stills with agitators.
- 1—Jeffrey crusher.
- 1—Hunter Lightning mixer and sifter.
- 2—Sweetland filter presses.
- 1—50 H.P. Gas engine with producer.
- 1—100 K.W. Turbo-generator.
- 1—Air compressor, 9½" x 9½" x 10".
- 1—Air compressor, 10" x 10", belt driven.
- 1—Buffalo vacuum pump 10" x 10".
- 1—100 Gal. Acid egg.

*Send Us Your Inquiries!  
Let Us Buy  
Your Idle Equipment!*

**Machinery Utilities Co.**  
501 Fifth Avenue  
New York City

# SEARCHLIGHT SECTION

## New Transformers in Stock

2200 volt primary—single phase—all sizes up to 30 KVA.  
4400 and 6600 volt primary—single phase—sizes up to 10 KVA.  
2200 and 4400 volt primary—three phase—sizes up to 20 KVA.  
Deliveries on all other sizes 3 to 6 weeks.

Prompt Delivery on All Sizes  
up to 1500 KVA.

Steam & Electrical Machinery Co.  
Bay City, Mich.

## TANKS

Twenty (20)

### Square Wooden Tanks

2" thick, 6' by 6' by 5' deep, lined with two inches of reinforced concrete. In good condition. Cheap. F. S. 1447 (N. Y.)—Met. & Chem. Eng., N. Y. C.

## For Quick Sale Scleroscope

In our recent big purchase of the Kennicott Co. we secured one complete Shore Scleroscope, for measuring the hardness of metals.

Write for details and low, quick sale prices.

HARRIS BROTHERS CO.  
CHICAGO

## FOR SALE

2—6 x 8

### Double Plunger Earthenware Pumps

complete with countershafts, with 9 step cone pulleys. Made especially for pumping chlorine gas.

THE MORSE BROS. MACH'Y &  
SUPPLY CO.

1732 Wazee St.

Denver, Colo.

## FOR SALE: 1—No. A8 Ruggles-Coles Dryer

60 in. diameter, 30-ft. length, complete with Bases and Driving Mechanism.

In fine condition.

COMMERCIAL ACID CO., St. Louis, Mo.

# TRANSFORMERS

## FOR SALE

No.	KVA.	Primary	Volts	Cycles
1	20	220	50-25	25
1	20	220	10-5	25

1—Holtzer-Cabot GENERATOR 15 K.W., 50 volts, 1150 R.P.M., type "C," new.

E. S. LINCOLN, Inc., 25 Silver Street, Waterville, Maine

## Electrically Lighted Drafting Tables

Three specially constructed adjustable drafting tables with stools

## FOR SALE

Glass tops with electric lights placed in reflecting trough beneath the top.

Four different light intensities insure the proper light for any form of tracing.

Very heavy construction and just as good as new.

## A Bargain to Quick Buyer

Address Office Manager

McGraw-Hill Publishing Co., Inc.  
239 W. 39th St., New York

## FOR SALE

### Four Hornsby & Akroyd Oil Engines 25 Horse Power Each

First Class Condition

Empire Smelting & Refining Co., 210 San Francisco St., P. O. Box 443, El Paso, Tex.

6000 and 8000 gal. **Car** Suitable for storage.

## Tanks

### Immediate Shipment

### Also New Tanks

8000, 10,000, and 12,000 gal.

Better Wire.

### Exceptional Bargains

in

Rails Piling  
Cars Tanks  
Locomotives Equipment

Have you a copy of our 20-page  
bargain bulletin?

**ZELNICKER IN ST. LOUIS**

## WANTED

### Continuous Grinding Tube Mill

not to exceed 16 ft. long; must be Silica-lined with Flint Pebbles for grinding wet material, to pass a screen 150 to 200 mesh per inch. Give full information as to condition, name of manufacturer, and lowest price, with horse power required to operate.

Also two (2) large heavy duty

PEBBLE MILLS

THE OHIO POTTERY CO.,  
Zanesville, Ohio.

## WANTED

### Rotary Cement OR Lime Kiln

with cooler—size between 110 ft. and 140 ft. length—7 ft. to 8 ft. in diameter. Must be in good condition and ready for delivery in Three Months. W., 1491 (Mich.), Met. & Chem. Eng., Old Colony Bldg., Chicago.

## WANTED

### Wooden Filter Press

of the washing plate and frame type; 100 to 200 square feet of filtering area.

DYE PRODUCTS & CHEMICAL CO.,  
187 Pioneer St., Newark, N. J.

## WANTED

One 30 to 40" Centrifugal, Steel curb

### Brass or Steel Basket

bottom discharge, belt-driven. Also one 40" Centrifugal, acid resistant, bottom discharge, direct or belt-driven. State manufacturer and full particulars.

PACIFIC COAST BORAX CO.  
Bayonne, N. J.



# SEARCHLIGHT SECTION

## Get your Wants into the Searchlight

### ADVERTISING RATES

Under "Positions Wanted," including Salesmen looking for new connections, Evening Work Wanted, etc., undisplaced advertisements cost **three cents a word**, minimum charge 50 cents an insertion, payable in advance; less 10% if one payment is made in advance for 4 continuous insertions.

Under "Positions Vacant," including Agents and Agencies Wanted, Representatives Wanted, Salesmen Wanted, Partners Wanted, Business Opportunities, Employment Agencies, and Miscellaneous For Sale, For Rent, and Want

ads; also Auction Notices, Receivers' Sales, Machinery and Plants For Sale or Wanted, undisplaced advertisements set solid in one paragraph, cost **five cents a word**, minimum charge \$1.50 an insertion.

Machinery advertisements (undisplaced) set with a paragraph for each item, or tabulated, 30 cents a line, minimum 5 lines.

If replies are in care of any of our offices, allow five words for the address.

Advertisements for bids (Proposals) \$2.40 an in.

### ADVERTISEMENTS IN DISPLAY TYPE

1/8 p. (1 1/2 x 3 3/4 ins.).....	\$5.00	1 in. (1 x 2 1/2 ins.).....	\$3.00
1/4 p. (2 1/2 x 3 3/4 ins.).....	10.00	4 inches (4 x 2 1/2 ins.)..	11.60
3/4 p. (5 x 3 3/4 or 2 3/4 x 7 ins.).....	20.00	8 inches (8 x 2 1/2 ins.)..	22.40
1/2 p. (10 1/2 x 3 3/4 or 5 x 7 ins.).....	40.00	15 inches.....	40.50

For space to be used within one year, to be divided to suit requirements of advertiser, provided some space is used at least once a month following first insertion:

1 page.....	\$80 a page	9 pages.....	\$65 a page
3 pages.....	75 a page	12 pages.....	60 a page
6 pages.....	70 a page	18 pages.....	55 a page

In replying to advertisements, do NOT enclose original testimonials, or anything that you may want returned. State your qualifications in as concise and neat a manner as you can and enclose COPIES of testimonials. In machinery ads, use a local name or address if possible so that readers can wire direct and get quick replies.

### FOR SALE

#### For Sale

7 pressure tanks.  
4 cast iron pots.  
4 cracking presses.  
2 filter presses.  
The Berg Company, Philadelphia, Pa.

#### Calcined Aluminum Oxide for Sale

100 tons monthly running 3 per cent silica, and three-tenths of one per cent iron, at 3 cents a pound. F. S., 1513 (Pa.), Met. & Chem. Eng., Phila.

#### Bauxite for Sale

Bauxite, of best alum grade, 2 cars weekly spot delivery at \$9 per ton, Alabama shipping point. F. S., 1515 (Pa.), Met. & Chem. Eng., Phila.

### MISCELLANEOUS WANTS

#### Wanted at Once

For immediate shipment any quantity of battery lead plates, sediment scrap copper and wire, brass and all other grades of scrap material. Write to us today for our prices. National Metal & Rubber Co., 31 India Wharf, Boston, Mass.

### BUSINESS OPPORTUNITIES

#### Bauxite Property for Sale

Bauxite property in Arkansas, 200 acres of high-grade ore on the railroad. B. O., 1514 (Pa.), Met. & Chem. Eng., Phila.

### PATENT ATTORNEYS

PATENT ATTORNEY desires to make special arrangement with a corporation to handle all or part of its patent work. Special qualifications for chemical process, product and apparatus matters. Address W. 1489 (N. Y.), Met. & Chem. Eng., N. Y. C.

### POSITIONS WANTED

CHEMICAL engineer, graduate, wide general experience in research, metallurgical, manufacturing, physical, electrochemical lines, etc., organic and inorganic, many years chief chemist large laboratories. Only responsible, first-class position considered. Full particulars and references. P. W. 1418 (Ark.)—Met. & Chem. Eng., Chicago.

### POSITIONS WANTED

CHEMICAL and metallurgical engineer, college man, 37, with wide experience in design, construction and operation of ore treatment plants, with some executive and sales experience, thoroughly familiar with iron and steel manufacture and metallurgy, trained chemist, organic and inorganic, will be open for engagement after Aug. 1. Desires position in plant management, research, development, engineering or operation of metallurgical or chemical plant. Present salary \$4,000 per year. References furnished. Will consider taking stock in small or new manufacturing plant. P. W. 1502 (Pa.), Met. & Chem. Eng., Philadelphia.

CHEMIST and Mechanical Engineer, five years' experience, desires position affording opportunities for advancement. P. W. 1454 (Ind.)—Met. & Chem. Eng., Chicago.

CHEMIST young man technical graduate, one year experience, good analyst. Wishes position, moderate salary with chance of advancement. P. W., 1479 (N. Y.) Met. & Chem. Eng., N. Y. C.

CHEMIST—Experienced analyst, generally, but especially precious and rare metals, copper, lead, zinc, iron. P. W. 1505 (N. Y.), Met. & Chem. Eng., N. Y. C.

CHEMIST, several years' experience, desires position in research laboratory or plant. Possesses initiative and originality and can handle labor. P. W. 1504 (Pa.), Met. & Chem. Eng., Philadelphia.

CHEMIST, 10 years' experience in general laboratory and plant work, desires a position as chief or operating chemist, at moderate salary. P. W. 1503 (Ind.), Met. & Chem. Eng., Chicago.

CHEMIST, age 30, desires position as executive or manager. Experience: analytical, research, development, executive, plant operator in steel mill, oil refinery, municipal food inspection, acid plant and grinding wheel factory. Very successful, capable, strong personality, graduate U. of Penna.; healthy and hard worker. P. W. 1500 (Pa.), Met. & Chem. Eng., Philadelphia.

### Seventeen Years' Experience

Research, Manufacture, Electro-Metallurgical processes, Ferro-Alloys, Electro-Chemical problems, Plant construction and operation. Strictly confidential. P.W. 1456 (Ont.)—Met. & Chem. Eng., Chicago.

### POSITIONS WANTED

CHEMIST with thorough analytical and production experience. Object especially advancement. Married. P. W., 1499 (Mich.), Met. & Chem. Eng., Chicago.

CHEMIST, research, analyst. Can reproduce any commercial product. Charles B. Davis, 492 Convent Avenue, N. Y. C.

CHEMIST—Young man at present located, in Detroit, wishes a position as analytical chemist in Chicago. Six years' experience in ores and in materials used in automobile manufacture. Able to install a laboratory in iron or brass foundry. Good references furnished, and can report on short notice. P. W. 1495 (Mich.), Met. & Chem. Eng., Chicago.

CHEMISTRY, young man, 22, inexperienced, with knowledge and training in organic and analytical chemistry, desires position as beginner. P. W., 1511 (N. Y.), Met. & Chem. Eng., N. Y. C.

CHIEF chemist, 12 years' experience in metallurgical analysis, including electric furnace production of ferro-manganese and steel. Well qualified and highest references. P. W. 1496 (Ala.), Met. & Chem. Eng., Philadelphia.

CORNELL University graduate, with about three years' general analytical experience, wants position in industrial research chemistry. Address Miss Brown, 251 W. 25th St., New York City.

ELECTROMETALLURGICAL engineer, technical graduate, wide experience in smelting and electrolytic refining of copper, desires correspondence with firm requiring a man with executive ability for position of responsibility. Salary \$2,500. P. W. 1433 (N. J.)—Met. & Chem. Eng., N. Y. C.

ELECTROMETALLURGIST, technical graduate, married, three years' experience as chief chemist and production engineer on electric smelting and refining of ferro alloys. P. W. 1494 (Pa.), Met. & Chem. Eng., Philadelphia.

GRADUATE chemist experienced in iron, steel and ferro-alloy analysis, design and operation of electric furnace ferro-silicon plant. Now under contract, open for engagement Sept. 1. P. W. 1483 (N. Y.), Met. & Chem. Eng., N. Y. C.

# SEARCHLIGHT SECTION

## POSITIONS WANTED

**GRADUATE** chemist (Ph.B.), formerly with large manufacturing concern, familiar with testing of raw materials and general investigation work—glass, refractory materials, graphite products, oils, paints, lubricants, and commercial organic analysis—seeks position in New York City or immediate vicinity at moderate salary. P. W. 1493 (N. Y.), Met. & Chem. Eng., N. Y. C.

**METALLURGICAL** chemist, wide experience in the manufacture and analysis of non-ferrous metals, brasses, babbitts, etc., and the concentration, smelting and refining of secondary metals. P. W. 1484 (Ill.), Met. & Chem. Eng., Chicago.

**UNIVERSITY** graduate (1917) in chemical engineering desires a position. Salary \$76 a month. P. W. 1512 (N. Y.), Met. & Chem. Eng., N. Y. C.

**YOUNG** man, recent graduate in chemistry, from Cooper Union, desires a position as assistant chemist in the laboratory of an established chemical concern. Willing to start at a moderate salary. P. W. 1497 (N. Y.), Met. & Chem. Eng., N. Y. C.

## POSITIONS VACANT

**A FIRST** class electric smelting and reduction company in the Middle West wants a metallurgist thoroughly familiar with iron, steel and alloys, possibly Ph. D., to manage the plant. Liberal salary and permanent position for right man. Applications handled in strict confidence. Address P. 1431 (Ill.)—Met. & Chem. Eng., Chicago.

**A man with personality, some business, and chemical or chemical engineering experience is needed for a work that requires sales ability. To the right man a splendid opportunity is open. State qualifications, references, salary expected.**

P., 1507 (N. Y.), Met. & Chem., N. Y. C.

## We Buy

ideas—and develop and market them on a royalty basis.

**GIBB INSTRUMENT CO.**

5716 Euclid Ave. Cleveland, Ohio

## POSITIONS VACANT

**CAPABLE** party wanted to superintend manganese mining operations and shipment of product. Have large deposits opened up, both metallic and dioxide manganese. Address Manganese P. 1445 (Ore.)—Met. & Chem. Eng., Chicago.

**EXPERIENCED** man wanted to erect and operate plant to manufacture electrodes for electric furnaces. Address Electrode, P. 1446 (Ore.)—Met. & Chem. Eng., Chicago.

**EXPERIENCED** man wanted to manage an electrolytic, caustic, and chloride of lime plant. Good chance of advancement. State age, experience and salary required. P. 1485 (N. C.), Met. & Chem. Eng., Philadelphia.

**ELECTRODES**—Experienced man to go abroad as master foreman in electrode factory. Give age, experience, nationality, and wages expected. P. 1510 (N. Y.), Met. & Chem. Eng., N. Y. C.

**METALLURGIST**—Firm making steel automobile parts, one of the largest in its field, needs a competent metallurgist. Familiarity with modern chemical and metallographical control is essential. Must have sufficient initiative to lay out proper methods and the necessary personality to see that those methods are followed. Address P. 1488 (Pa.), Met. & Chem. Eng., Philadelphia.



**NEED A  
Mill  
Superintendent?**

Assayer, Chemist,  
Engineer?  
Wire or write  
**Business Men's  
Clearing House**  
Denver, Colo.

## The Searchlight Advertising in This Paper

is read by men whose success depends upon thorough knowledge of means to an end—whether it be the securing of a good second-hand piece of apparatus at a moderate price, an expert chemical or metallurgical engineer or superintendent, or the services of a firm of engineers for designing a large modern plant.

## The Best Proof

of this is the regularity with which such advertisements are carried—and the variety of this journal's Want ads. Without a constant and appreciable demand for such machinery or services, by its readers, the market-place which these advertisements represent could not exist for any length of time.

Are you using the Searchlight Section?

**Metallurgical and  
Chemical Engineering**  
239 W. 39th St., New York

## AGENTS AND SALESMEN

### Engineering Salesman Wants Position

Position wanted by man of forty, as engineering salesman on new and difficult propositions. Experience wide and detailed, acquainted with banking and engineering circles. All technical business training. Salary not prime object. Friends say he has excess of assurance. Address S. 1444 (N. Y.)—Met. & Chem. Eng., N. Y. C.

## EMPLOYMENT AGENCIES

### Correspondence Service

The undersigned provides a confidential service designed to locate openings through correspondence, for men earning not less than \$2,500 and up to \$25,000; all lines. Not an employment agency but a constructive, initiative service, covering individual negotiations. Established 1910. Complete privacy assured; present connections in no way jeopardized. Send name and address only for explanatory details. R. W. Bixby, D1, Niagara Square, Buffalo, N. Y.

**C** Chemists seeking suitable positions  
**H** and employers seeking suitable chem-  
**E** ists should write Julian M. Blair,  
Secretary,  
**M** **THE CHEMISTS'**  
**I** **EMPLOYMENT BUREAU**  
**S** **Nashville, Tenn.**  
**T** No charge to employers. No initial  
**S** expense to chemists. Foreign appli-  
cations solicited.

## WANTED

### Factory Manager

experienced in the rubber industry, especially in compounds and compounding .....\$5,000

### Research Chemist

to manage laboratory doing research work on aluminum .....\$2,500

### Foremen

Several department foremen experienced on mechanical rubber goods and hydraulic leather packing.  
Approx. \$2,000

### National Employment Exchange

Officers and Directors:  
Otto T. Bannard, President  
John R. MacArthur, Vice-President  
Francis L. Hine, Treasurer  
Eugene H. Outerbridge, Secretary  
Robert W. DeForest, Newcomb Carlton  
L. F. Lorce, Arthur Williams  
G. S. Anthony, General Manager

30 Church Street, New York City

# What Advertisers Offer to Readers

Classified Index of Products Advertised in This Issue by Representative Manufacturers and Dealers

## Acetylene in Cylinders

Prest-O-Lite Co.

## Acid Concentration Apparatus

Chemical Construction Co.  
Durrion Castings Co.  
International Glass Co., The  
Kilberry Corp., The  
Pratt Eng. & Machine Co.  
Thermal Syndicate, Ltd., The

## Acid Distillation Apparatus

Buffalo Foundry & Machine Co.  
Fulton Foundry Co.  
Thermal Syndicate, Ltd., The

## Acid Eggs, Cast Iron

Bethlehem Fdry. & Mach. Co.  
Buffalo Fdry. & Mach. Co.  
Devine Co., J. P.  
Elvira Enamelled Products Co.  
Fulton Foundry Co.  
Stearns-Roger Mfg. Co.  
Stuart & Peterson Co.  
U. S. Cast Iron Pipe & Fdry Co.

## Acid Eggs, Stoneware, Acid Proof

Knight, M. A.  
U. S. Stoneware Co.

## Acid Resisting Glass Enamelled Apparatus

See Enamelled Apparatus, Acid Resisting

## Acid, Sulphuric

New Jersey Zinc Company, The

## Acid Ware

See Enamelled Ware, Glassware, Porcelain, Silica and Stoneware

## Agitating Machinery

Caldwell, W. E., Co.

## Agitator Tanks, Wood

Caldwell, W. E., Co.  
Redwood Manufacturers Company.  
Schwarzwald, J., & Sons, Inc.

## Agitators

Caldwell, W. E., Co.  
Dorr Co., The  
General Filtration Co., Inc.  
U. S. Stoneware Co.

## Air Conditioning Apparatus

Braemer Air Conditioning Co.  
Carrier Engineering Corp.  
Spray Engineering Co.

## Air Separators

See Separators, Air

## Air Washers

American Blower Co.  
Braemer Air Conditioning Co.  
Carrier Engineering Corporation

## Alloys

See Ferro-Alloys

## Alloys, Special

Goldschmidt-Thermit Co.  
Lavino, E. J., & Co.  
Norton Laboratories, Inc.

## Aluminum

Electric Smelt. & Alum. Co.

## Amines

Newport Chemical Works, Inc.

## Analytical Apparatus

Alnsworth, Wm., & Son  
Bausch & Lomb Opt. Co.  
Braun Corporation, The  
Braun-Knecht-Heinmann Co.  
Buffalo Dental Mfg. Co.  
Dalgner, A., & Co.  
Elmer & Amend.  
Hoskins Mfg. Co.  
Laboratory Apparatus Co., Pitts-

burgh  
Laboratory Supply Co.  
Mine & Smelter Supply Co.

## Apparatus

Palo Co.  
Sargent, E. H., & Co.  
Scientific Materials Co.  
Thomas Co., Arthur H.

## Analyzers, Gas & Automatic

Williams Apparatus Company

## Asbestos Cloth, Yarn, Banding Tape and Fibre

Asbestos Protected Metal Co.

## Ash Handling Machinery

Guarantee Construction Co.

## Assayers

See Professional Directory, Pages 114, 115

## Autoclaves

Aetna Steel Products Co.  
Buffalo Foundry & Machine Co.  
Devine, J. P., Co.  
Ott, Geo. F., Co.  
Valley Iron Works (Williamsport, Pa.)

## Automatic Car Drive Systems

Pratt Eng. & Machine Co.

## Balances and Weights

Alnsworth, Wm., & Son  
Bausch & Lomb Opt. Co.  
Braun Corporation, The  
Braun-Knecht-Heinmann Co.  
Elmer & Amend.  
Gaertner, Wm., & Co.  
Laboratory Supply Co.

## Mine & Smelter Supply Co.

Ohio Pottery Co.  
Palo Co.  
Schaar & Co.

## Ball Mills

See Mills, Ball, Pebble, Tube  
Barrels, Steel, Bilge, Agitator & Open Head  
Detroit Range Boiler Co.

## Bauxite

Laclede-Christy Clay Products Co.  
Lavino, E. J., & Co.

## Belt Conveyors

Caldwell, H. W., & Son Co.  
Link-Belt Company  
Stephens-Adamson Mfg. Co.  
Webster Mfg. Co., The

## Bins, Steel and Concrete

Aetna Steel Products Co.  
Brown Hoisting Machinery Co.

## Blowers, Fan or Positive Pressure

Abbé Engineering Co.  
Abbé, Paul O.  
American Blower Co.  
Beach-Russ Company  
Buffalo Forge Co.  
Clarage Fan Co.  
Connersville Blower Co.  
Nash Engineering Co.

## Blowers, Flotation

Connersville Blower Co.  
Nash Engineering Co.

## Bollers, Water Tube

Vogt, Henry, Machine Co.

## Bolting Cloths, Silk

Abbé Engineering Co.  
Abbé, Paul O.

## Books

McGraw-Hill Book Company  
Wiley, John, & Sons.

## Brick, Acid Proof

Chemical Construction Co.  
General Ceramics Co.  
Harbison-Walker Refractories Co.  
Knight, M. A.  
Laclede-Christy Clay Products Co.  
Milton Brick Co.  
U. S. Stoneware Co.

## Brick and Clay, Fire

Foots Mineral Co.  
Harbison-Walker Refractories Co.  
Laclede-Christy Clay Products Co.  
Mine & Smelter Supply Co.

## Brick, Chrome

Harbison-Walker Refractories Co.

## Brick Insulating

Armstrong Cork & Insulation Co.  
Celite Products Co.

## Brick, Silica

Harbison-Walker Refractories Co.  
Laclede-Christy Clay Products Co.

## Bronze, Titanium Aluminum

Titanium Alloy Mfg. Co., The

## Brushes, Carbon

National Carbon Co.

## Buckets, Clamshell & Drag Line

Brown Hoisting Machinery Co.

## Bucket Elevators

Caldwell, H. W., & Son Co.  
Link-Belt Company  
Stephens-Adamson Mfg. Co.  
Webster Mfg. Co., The

## Burners, Acetylene

Prest-O-Lite Co.

## Burners, Gas and Oil

Braun Corporation, The  
Braun-Knecht-Heinmann Co.  
Mine & Smelter Supply Co.  
Rockwell, W. S., Co.

## Burners, Sulphur

Glens Falls Machine Co.  
Pratt Eng. & Machine Co.  
Valley Iron Wks. (Appleton, Wis.)

## Calcium Carbide

Union Carbide Co.

## Calculating Machines

Marchant Calculating Machine Co.

## Caldrons

Hand, Edward L., & Co.

## Calorimeters

Emerson Apparatus Co.  
Gaertner, Wm., & Co.  
Palo Co.  
Sargent, E. H., & Co.  
Schaeffer & Budenburg Mfg. Co.  
Thomas Co., Arthur H.

## Carbons, Battery

National Carbon Co.

## Carbons, Resistance

National Carbon Co.

## Cars, Industrial

Easton Car & Construction Co.  
Lakewood Engineering Co.

## Cars, Mine and Ore

Easton Car & Construction Co.  
Lakewood Engineering Co.

## Cascade Basins, Acid Proof

Durrion Castings Co.  
Thermal Syndicate, Ltd., The

## Casseroles

Guernsey Earthenware Co.  
Herold China & Pottery Co.  
Laboratory Supply Co., The

## Castings, Acid Proof

Bethlehem Fdry. & Mach. Co.  
Buffalo Fdry. & Mach. Co.  
Durrion Castings Co.  
Fulton Foundry Co.  
Lunkenheimer Co., The.  
Pacific Foundry Co.  
Pratt Eng. & Machine Co.  
U. S. Cast Iron Pipe & Fdry. Co.

## Castings, Bronze & Brass

Titanium Alloy Mfg. Co., The

## Castings, Chemical

Bethlehem Fdry. & Mach. Co.  
Buffalo Fdry. & Mach. Co.  
Durrion Castings Co.  
Jacoby, Henry E.  
Lunkenheimer Co., The.  
Moore, Sam'l L., & Son  
Pacific Foundry Co.  
Sperry, D. E., & Co.  
Valley Iron Works.

## Castings, Iron

American Cast Iron Pipe Co.  
Cast Iron Pipe Publicity Bureau  
Lunkenheimer Co., The.

## Castings, Lead

Craig Foundry Co.

## Castings, Monel Metal

Supple-Biddle Hdw. Co.

## Castings, Pure Copper

Titanium Alloy Mfg. Co., The

## Castings, Special & Chilled

Fulton Foundry Co.  
Ferrin, Wm. H., & Co.  
U. S. Cast Iron Pipe & Fdry. Co.

## Caulstic Pots

See Pots, Cast Iron, Acid Proof

## Caulstic Soda and Chlorine

Electrolytic Cells for Making  
Electro Chemical Co., The  
Electrolytic Engineering Corp.  
Electron Chemical Co.  
Warner Chemical Co.

## Caulsticizing Apparatus

Dorr Co., The  
Scott, Ernest, & Co.  
Zaremba Co.

## Cement, Acid Proof

Anti-Hydro Waterproofing Co.

## Cement Furnace

Quigley Furnace Specialties Co.

## Centrifuges

Schaum & Uhlinger, Inc.  
Sharples Specialty Co.  
Tolhurst Machine Works  
Wayte, W. J., Inc.

## Chain Doors

Codd, B. J., Co.

## Chemical Apparatus

See Acid Eggs, Castings Chemical, Distilling Machinery and Apparatus, Drying Machinery and Apparatus, Enamelled Apparatus, Evaporators, Filter Presses, Glassware, Separators, Centrifugal, Stoneware, etc.

## Chemical Engines

American La France Fire Engine Co.

## Chemical Stoneware

See Stoneware, Chemical.

## Chemicals

Baker, J. T., Chem. Co.  
Barrett Co., The.  
Braun Corporation, The.  
Braun-Knecht-Heinmann Co.  
Dalgner, A., & Co.  
Elmer & Amend.  
General Chemical Co.  
Laboratory Apparatus Co., Pitts-

burgh  
Marden, Orth & Hastings, Inc.  
Merck & Co.  
Mine & Smelter Supply Co., The.  
Newport Chemical Works  
Roessler & Hasslacher Chemical Co., The.

Sargent, E. H., & Co.  
Schaar & Co.  
Scientific Materials Co.  
Squibb, E. R., & Sons.

## Chemists, Manufacturing

Baker, J. T., Chem. Co.  
Merck & Co.  
Newport Chemical Works  
Roessler & Hasslacher Chemical Co., The.  
Squibb, E. R., & Sons.

## Chemists and Chem. Engrs.

See Professional Directory, Pages 114, 115

## Chlorine, Liquid

See Caustic Soda and Chlorine.

## Classifiers

Colorado Iron Works Co.  
Dorr Co., The.  
Worthington Pump & Mach. Corp.

## Clay Goods

See Brick and Clay, also Porcelain Ware, also Stoneware, Chemical.

## Coal Tar Pitch

Barrett Co., The.

## Coal Tar Products

Newport Chemical Works, Inc.

## Cocks, Cast Iron, Acid Proof

See Valves and Cocks, Cast Iron, Acid Proof.

## Cocks, Stoneware, Acid Proof

See Valves and Cocks, Stoneware, Acid Proof.

## Coils, Copper

Badger, E. B., & Sons Co.  
Lummus, The W. E. Co.  
Roos, August, & Son.  
Swenson Evaporator Co.  
Werner & Pfeiderer Co.  
Zaremba Co.

## Coils & Worms, Stoneware

See Stoneware, Chemical.

## Combustion Boats

Engelhard, Chas.

## Compressors, Air or Gas

Crowell Mfg. Co.  
General Electric Co.  
Nash Engineering Co.

## Concentrating Tables

Mine & Smelter Supply Co., The.

## Concrete Hardening Compound (Liquid)

Anti-Hydro Waterproofing Co.

## Condensers, Barmometric, Surface or Jet

Buffalo Fdry. & Mach. Co.  
Connersville Blower Co.  
Devine Co., J. P.

## Converters, Rotary

General Electric Co.  
Lincoln Electric Co., The.

## Conveying Machinery

See Machinery, Elevating and Conveying.

## Coppers

Taylor, N. & G., Co.

## Coppersmithing

Badger, E. B., & Sons Co.  
Lummus, The Walter E., Co.  
Ott, George F., Co.  
Roos, August, Son.

## Cranes

Brown Hoisting Machinery Co.

## Cranes, Locomotive

Link-Belt Company

## Crucibles

Buffalo Dental Mfg. Co.  
Durrion Castings Co.  
Guernsey Earthenware Co.  
Laboratory Supply Co.  
Mine & Smelter Supply Co., The.  
Thermal Syndicate, Ltd., The.

## Crucibles, Graphite

Acheson Graphite Co.

## Crucibles and Dishes, Flat-Iron

Baker & Co., Inc.  
Bishop, J., & Co., Platinum Wks.

## Crushers, Grinders and Pulverizers

See Machinery, Crushing, Grinding and Pulverizing.

## Crushers, Grd. Pulv., Lab.

See Machinery, Crushing, Grinding and Pulverizing Laboratory.

## Crystallizing Dishes & Pans, Stoneware

See Stoneware, Chemical.

## Crystallizing Pans, Cast Iron

Buffalo Foundry & Machine Co.  
Devine Co., J. P.  
Pfaudler Company.

## Curb Boxes, Meter

American Cast Iron Pipe Co.  
Cast Iron Pipe Publicity Bureau.

## Cyanide

Roessler & Hasslacher Chemical Co.

## Cyanide Machinery

See Machinery, Cyanide.

## Cyanide Tanks

Caldwell, W. E., Co.

## Diaphragms, Acid Proof

General Filtration Co., Inc.

## Die Castings (Bronze)

Titanium Alloy Mfg. Co., The

## Diffusion Batteries

Blair, Campbell & McLean, Ltd.  
Lummus, The W. E., Co.  
Swenson Evaporator Co.



**Digesters**

Aetna Steel Products Co.  
Elyria Enameled Products Co.  
Hend, Edward L. & Co.  
Manitowoc Engineering Works.  
Pratt Eng. & Machine Co.  
Stuart & Peterson Co.  
Swenson Evaporator Co.  
Werner & Pfleiderer Co.

**Distilling Machy. and Apparatus**

Aetna Steel Products Co.  
Badger, E. B. & Sons Co.  
Blair, Campbell & McLean, Ltd.  
Detroit Heating & Lighting Co.  
Devine Co., J. P.  
Durlon Castings Co.  
Elyria Enameled Products Co.  
Fulton Foundry Co.  
Isbell-Porter Co.  
Koven, L. O., & Bro.  
Lummas, The W. E., Co.  
Mott, J. L., Iron Works  
Ott, George F., Co.  
Pfaudler Co., The.  
Roos', August, Son.  
Scott, Ernest, & Co.  
Stevens-Alsworth Co.  
Thomas Co., Arthur H.  
Stuart & Peterson Co.  
Swenson Evaporator Co.  
Werner & Pfleiderer Co.  
Zaremba Co.

**Door Screens**

Codd, E. J. Co.

**Drop Forge Fittings**

Vogt, Henry, Machine Co.

**Drums, Steel**

Detroit Range Boiler Co.

**Dry Blast Plants**

Carrier Engineering Corporation.

**Dry Cell Filter**

Acheson Graphite Co.

**Dryers, Chemical**

Schaum & Uhlinger, Inc.

**Dryers, Vacuum**

Sharples Specialty Co.

**Drying Ma. h. & Apparatus**

Tolhurst Mach. Works.

**Drying Ma. h. & Apparatus**

American Blower Co.

**Drying Ma. h. & Apparatus**

American Process Co.

**Drying Ma. h. & Apparatus**

Buffalo Forge Co.

**Drying Ma. h. & Apparatus**

Buffalo Foundry & Machine Co.

**Drying Ma. h. & Apparatus**

Clarage Fan Co.

**Drying Ma. h. & Apparatus**

Devine Co., J. P.

**Drying Ma. h. & Apparatus**

Gordon Engineering Corp.

**Drying Ma. h. & Apparatus**

Koven, L. O., & Bro.

**Drying Ma. h. & Apparatus**

Manitowoc Engineering Works.

**Drying Ma. h. & Apparatus**

Redfield, R. S.

**Drying Ma. h. & Apparatus**

Ruggles-Coles Eng. Co.

**Drying Ma. h. & Apparatus**

Scott, Ernest, & Co.

**Drying Ma. h. & Apparatus**

Stearns-Roger Mfg. Co.

**Drying Ma. h. & Apparatus**

Swenson Evaporator Co.

**Drying Ma. h. & Apparatus**

Vulcan Iron Works.

**Drying Ma. h. & Apparatus**

Werner & Pfleiderer Co.

**Drying Ma. h. & Apparatus**

Williams Patent Crusher & Pulverizer Co.

**Drying Ma. h. & Apparatus**

York Corrugating Co.

**Dyes and Dyestuffs**

Marden, Orth & Hastings, Inc.

**Dynamics, Electroplating**

See Electroplating Dynamos: Supplies.

**Dynamics and Motors**

Bogus, C. J., Elect. Co.

**Dynamics and Motors**

General Electric Co.

**Dynamics and Motors**

Jants & Leist Elect. Co.

**Dynamics and Motors**

Lincoln Electric Co.

**Dynamics and Motors**

Westinghouse Electric & Mfg. Co.

**Electric Cranes**

See Cranes

**Electric Furnace Accessories**

Volta Mfg. Co., The.

**Electric Furnaces**

See Furnaces, Electric

**Electric Furnaces, Lab'y.**

See Furnaces, Elec. Lab'y.

**Electrical Supplies**

General Electric Co.

**Electrical Testing Sets**

American Transformer Co.

**Electrode Holders**

Thordarson Electric Mfg. Co.

**Electrodes, Carbon**

Volta Mfg. Co., The.

**Electrodes, Carbon**

Acheson Graphite Co.

**Electrodes, Graphite**

National Carbon Co.

**Electrodes, Platinum**

Acheson Graphite Co.

**Electrodes, Platinum**

American Platinum Works.

**Electrodes, Platinum**

Baker & Co., Inc.

**Electrodes, Platinum**

Bishop, J. & Co., Platinum Works.

**Electrolytic Cells**

Electro Chemical Company, The.

**Electrolytic Cells**

Electrolytic Eng. Corp.

**Electrolytic Cells**

Electron Chemical Co.

**Electrolytic Cells**

Warner Chemical Co.

## What Advertisers Offer to Readers

Classified Index of Products Advertised in This Issue by  
Representative Manufacturers and Dealers

**Electroplating Dynamos:**

**Supplies**

Bogus, C. J., Elect. Co.

Jants & Leist Elect. Co.

**Electrolytic Salts**

Roesler & Haasler Chem. Co.

**Elevating and Conveying Machinery**

See Machinery, Conveying and Elevating.

**Enameled Apparatus Acid Resisting**

Elyria Enameled Apparatus Co.

Mott, J. L., Iron Works

Pfaudler Co., The.

Stearns-Roger Mfg. Co.

Stuart & Peterson Co.

**Engineers, Chemical, Consulting, Analytical, Industrial**

Also see Professional Directory.

Pages 114, 115

Kalpersky Corp., The.

Little, Arthur D., Inc.

Powdered Coal Eng. & Equipment Co.

Pratt Eng. & Machine Co.

Southwestern Engineering Co.

Volta Mfg. Co., The.

Wayte W. J., Inc.

Williams Apparatus Company.

**Engineers, Combustion**

Improved Equipment Co.

Surface Combustion Co.

**Engineers' Construction**

Chemical Construction Co.

Foundation Co.

Green, Samuel M., Co.

Guarantee Construction Co.

Southwestern Engineering Co.

**Engineers, Furnace**

Hagan, Geo. J., Co.

Rockwell, W. S., Co.

Russell Engineering Company.

Surface Combustion Co.

**Engineers, Pyrometric**

Holz, Herman A.

**Engines, Hoisting and Hauling**

Vulcan Iron Works.

**Equipment (2nd Hand)**

See Searchlight Section, Pages 116, 117, 118, 119, 120

**Evaporating Dishes**

Guernsey Earthenware Co.

Knight, M. A.

Thermal Syndicate, Ltd., The.

U. S. Stoneware Co.

**Evaporators**

Aetna Steel Products Co.

Allbright-Nell Co., The.

Badger, E. B., & Sons, Co.

Blair, Campbell & McLean, Ltd.

Buffalo Fdry. & Mach. Co.

Devine, J. P., Co.

Jacoby, Henry E.

Kestner Evaporator Co.

Koven, L. O., & Bro.

Lummas, The W. E., Co.

Ott, Geo. F., Co.

Pfaudler Co., The.

Pratt Eng. & Machine Co.

Redfield, R. S.

Roos', August, Son.

Scott, Ernest, & Co.

Sowers Manufacturing Co.

Swenson Evaporator Co.

Werner & Pfleiderer Co.

Zaremba Co.

**Extracts**

Marden, Orth & Hastings, Inc.

**Extractors**

Badger, E. B., & Sons Co.

Blair, Campbell & McLean, Ltd.

Koven, L. O., & Bro.

Lummas, The W. E., Co.

Ott, Geo. F., Co.

**Extractors, Centrifugal**

Schaum & Uhlinger, Inc.

Sharples Specialty Co.

Tolhurst Machine Works

**Fans**

Buffalo Forge Co.

Clarage Fan Co.

General Electric Co.

Pratt Eng. & Machine Co.

Raymond Bros. Impact Pulv. Co.

Stearns-Roger Mfg. Co.

Sturtevant Co., B. F.

Williams Patent Crusher & Pulv. Co.

**Fans, Stoneware, Acid Proof**

General Ceramics Co.

Knight, M. A.

U. S. Stoneware Co.

**Faucets, Stoneware, Acid Proof**

See Stoneware, Chemical.

**Feeders**

Stephens-Adamsen Mfg. Co.

Webster M'fg. Co., The.

**Ferro-Alloys**

Goldschmidt Thermit Co.

Lavino, E. J., & Co.

Leavitt, C. W., & Co.

Standard Alloys Co.

Titanium Alloy Mfg. Co.

**Ferro-carbon-Titanium**

See Titanium

**Fire Extinguishers**

American La France Fire Engine Co.

**Filter Cloth**

Huyck, F. C., & Sons

**Filter Paper**

H. Reeve Angel & Co.

Elmer & Amend

Laboratory Supply Co., The

**Filter, Porous Porcelain**

Herold China & Pottery Co.

**Filter Presses**

Albright-Nell Co., The

Colorado Iron Works Co.

Industrial Filtration Corporation

Jacoby, Henry E.

Johnson, John, Co.

Kelly Filter Press Co.

Koven, L. O., & Bro.

Lungwitz, E. E.

Oliver Continuous Filter Co.

Patterson Fdry. & Mach. Co.

Perrin, Wm. H., & Co.

Redfield, R. S.

Shriver, T., & Co.

Sperry, D. R., & Co.

Werner & Pfleiderer Co.

**Filter Press Distill'y Grains**

Swenson Evaporator Co.

**Filtrating Media**

Cellite Products Co.

General Filtration Co., Inc.

**Filters, Rotary Continuous**

Colorado Iron Works Co.

Industrial Filtration Corp.

Oliver Continuous Filter Co.

Southwestern Engineering Co.

**Filters, Suction, Stoneware, Acid Proof**

General Ceramics Co.

Knight, M. A.

**Filters, Vacuum**

General Filtration Co., Inc.

Stevens-Alsworth Co.

**Fire Brick and Clay**

See Brick and Clay, Fire

**Fireproof Building Materials**

Asbestos Protected Metal Co.

Floors & Pits, Acid Resisting

Anti-Hydro Waterproofing Co.

**Flotation Apparatus**

Braun Corporation, The.

Braun-Knecht-Heinmann Co.

Colorado Iron Works

Pennacola Tar & Turpentine Co.

Southwestern Eng. Co.

**Flotation Oil**

Pennacola Tar & Turpentine Co.

Standard Chemical Co.

**Fluorspar**

Lavino, E. J., & Co.

**Foundry Supplies**

**Intermediates**

Marden, Orth & Hastings, Inc.  
Newport Chemical Works, Inc.  
**Iron and Steel, Corrugated**  
Asbestos Protected Metal Co.

**Jigs**

Worthington Pump & Mach. Corp.  
**Kettles, Cast Iron Acid Proof**

Bethlehem Fdry. & Mach. Co.  
Buffalo Fdry. & Machine Co.  
Devine, J. P., Co.  
Duriron Castings Co.  
Fulton Foundry Co.  
Pacific Foundry Co.  
Pratt Eng. & Machine Co.  
Sowers Manufacturing Co.  
Stevens-Aylsworth Company.  
U. S. Cast Iron Pipe & Fdy. Co.  
Werner & Pfleiderer Co.

**Kettles, Enameled, Acid Proof**

Elyria Enameled Products Co.  
Mott, J. L., Iron Works  
Pfaudler Co.  
Stuart & Peterson Co.

**Kettles, Steam Jacketed**

Aetna Steel Products Co.  
Buffalo Fdy. & Machine Co.  
Day, The J. H., Co.  
Detroit Heating & Lighting Co.  
Devine Co., J. P.  
Duriron Castings Co.  
Elyria Enameled Products Co.  
Hand, E. L., & Co.  
Koven, L. O., & Bro.  
Mott, J. L., Iron Works.  
Ott, George F., Co.  
Pfaudler Company, The.  
Stevens-Aylsworth Co.  
Stuart & Peterson Co.  
Werner & Pfleiderer Co.

**Kettles, Stoneware, Acid Proof**

See *Stoneware Chemical*.

**Kilns, Lime**

Improved Equipment Co.

**Kilns, Rotary & Nodulizing**

American Process Co.  
Ruggles-Coles Eng. Co.  
Vulcan Iron Works.

**Laboratories, Chemical and Physical**

Lonkenheimer Co., The.  
**Laboratory Apparatus and Supplies**

Bausch & Lomb Opt. Co.  
Braun Corporation, The.  
Braun-Knecht-Heimann Co.  
Buffalo Dental Mfg. Co.  
Daigger, A., & Co.  
Elmer & Amend.  
Emerson Apparatus Co.  
Gaertner, Wm., & Co.  
Guernsey Earthenware Co.  
Hoskins Mfg. Co.  
International Glass Co.  
Laboratory Apparatus Co., Pitts-  
burgh.

Laboratory Supply Co., The.

Leeds & Northrup.

Mine & Smelter Supply Co., The.

Multi-Metal Separating Screen Co.

Palo Co.

Pyroelectric Instrument Co.

Sargent, E. H., & Co.

Schar & Co., The.

Scientific Materials Co.

Thomas Co., Arthur H.

**Laboratory Ware, Platinum**

Bishop, J., & Co., Platinum Wks.

**Lamp, Arc & Incandescent,**

**Tungsten**

General Electric Co.

Holz, H. A.

**Lead Burners**

Moore & Simonson

**Leaded Zinc Oxide**

New Jersey Zinc Company, The.

**Lifts, Air Jet**

Bethlehem Fdy. & Mach. Co.

Schutte & Koerting Co.

**Lithopone**

New Jersey Zinc Company, The.

**Locomotive Cranes**

Brown Hoisting Machinery Co.

**Locomotives, Gasoline**

Fate, The J. D., Co.

**Locomotives, Industrial**

Fate, J. D., Co.

General Electric Co.

Lakewood Eng. Co., The.

Vulcan Iron Works.

**Machinery, Agitating**

Day, The J. H., Co.

Dorr Co., The.

Werner & Pfleiderer Co.

**Machinery, Automatic**

Link-Belt Company.

**Weighting**

Pratt Eng. & Machine Co.

Schaffer Eng. & Equipment Co.

Werner & Pfleiderer Co.

**Machinery, Classifying**

Dorr Co., The.

**Machinery, Coal Grinding**

Aero Pulverizer Co.

Powdered Coal Eng. & Eqpt. Co.

Pratt Eng. & Machine Co.

Raymond Bros. Imp. Pulv. Co.

Williams Patent Crusher & Pulv. Co.

**Machinery, Conveying & Elevating**

Caldwell, H. W., & Son Co.

Guarantee Construction Co.

Link-Belt Company

Robins Conveying Belt Co.

Stephens-Adamsen Mfg. Co.

Webster Mfg. Co., The.

## What Advertisers Offer to Readers

Classified Index of Products Advertised in This Issue by  
Representative Manufacturers and Dealers

**Machinery, Crushing, Grinding and Pulverizing**

Abbé Eng'g Co.  
Abbé, Paul O.  
Aero Pulverizer Co.  
American Pulverizer Co.  
Colorado Iron Works Co.  
Day, J. H., Co.  
Dunning, W. D.  
Hardinge Conical Mill Co.  
K-B Pulverizer Co.  
Johnson Eng. Works.  
Kent Mill Co.  
Mead & Co.  
Mine & Smelter Supply Co.  
Patterson Fdy. & Mach. Co.  
Pratt Eng. & Machine Co.  
Raymond Bros. Imp. Pulv. Co.  
Sturtevant Mill Co.  
Vulcan Iron Works.  
Williams Patent Crusher & Pulverizer Co.  
Worthington Pump & Machy. Corp.

**Machinery, Crushing, Grinding & Pulverizing Lab'y**

Abbé Eng'g Co.  
Abbé, Paul O.  
Braun Corporation, The.  
Braun-Knecht-Heimann Co.  
Hardinge Conical Mill Co.  
Sturtevant Mill Co.  
Thomas Co., Arthur H.

**Machinery, Cyanide**

Colorado Iron Works Co.

Dorr Co., The.

Worthington Pump & Machy. Corp.

**Machinery, Electrical**

General Electric Co.

Lincoln Electric Co., The.

**Machinery, Metallurgical and Mining**

Abbé Eng'g Co.  
Abbé, Paul O.  
Aero Pulverizer Co.  
American Process Co.  
American Pulverizer Co.  
Colorado Iron Works Co.  
Dorr Co., The.  
Dwight & Lloyd Sintering Co.  
General Chemical Co., The.  
Hardinge Conical Mill Co.  
Johnson Eng. Works.  
Kelly Filter Press Co.  
K-B Pulverizer Co.  
Kent Mill Co.  
Lungwitz, E. E.  
Mine and Smelter Supply Company, The.

Pacific Foundry Co.

Raymond Bros. Imp. Pulv. Co.

Ruggles-Coles Eng. Co.

Stearns-Roger Mfg. Co.

Sturtevant Mill Co.

Vulcan Iron Works.

Wedge Mechanical Furnace Co.

Worthington Pump & Machy. Corp.

**Machinery, Mixing and Kneading**

Abbé Eng'g Co.

Abbé, Paul O.

Buffalo Fdy. & Machy. Co.

Day, J. H., Co.

Dunning, W. D.

Mead & Co.

Patterson Fdy. & Mach. Co.

Pratt Eng. & Machine Co.

Sowers Manufacturing Co.

Werner & Pfleiderer Co.

Worthington Pump & Machy. Corp.

**Machinery, Ore and Coal Handling**

Brown Hoisting Machinery Co.

Guarantee Construction Co.

Link-Belt Company

Stephens-Adamsen Mfg. Co.

**Machinery, Ore Concentrating**

Colorado Iron Works Co.

Dorr Co., The.

Kent Mill Co.

Ruggles-Coles Eng. Co.

Mine and Smelter Supply Company.

Worthington Pump & Machy. Corp.

**Machinery, Refrigerating**

Vogt, Henry, Machine Co.

**Machinery, Screening**

Link-Belt Company.

Stephens-Adamsen Mfg. Co.

Webster Mfg. Co., The.

Worthington Pump & Machy. Corp.

**Machinery, Soap**

Dunning, W. D.

**Machinery, Special**

Allbright-Neil Co., The.

Buffalo Fdy. & Machine Co.

Day, The J. H., Co.

Fulton Foundry Co.

Ruggles-Coles Eng. Co.

Stevens-Aylsworth Co.

Volts Mfg. Co., The.

Werner & Pfleiderer Co.

**Machinery, Thickening and Dewatering**

Dorr Co., The.

Werner & Pfleiderer Co.

**Machinery, Transmission**

Stephens-Adamsen Mfg. Co.

Webster Mfg. Co., The.

**Machinery, Weighing**

Schaeffer Eng. & Equipment Co.  
Sturtevant Mill Co.  
Werner & Pfleiderer Co.

**Magnetite**

American Mineral Production Co.  
Brunt, H. H., & Co.  
Foote Mineral Co.

Harbison-Walker Refractories Co.

**Magnesium Metal**

Leavitt, C. W., & Co.  
Norton Laboratories, Inc.

**Magnetic Pulleys**

Dings Magnetic Separator Co.

**Magnetic Separators**

Dings Magnetic Separator Co.

**Magnets**

Dings Magnetic Separator Co.

**Metal, Asbestos Protected**

Asbestos Protected Metal Co.

**Metallographic Apparatus**

Holz, Herman A.

Palo Co.

Scientific Materials Co.

**Metallo-Radiographic Apparatus**

Holz, Herman A.

**Metallurgical Engineers**

See *Professional Directory*, Pages 114, 115.

**Metallurgical Processes**

Dorr Co., The.

Dwight & Lloyd Sintering Co.

**Metals**

Electric Smelting & Alum. Co.

Goldschmidt Thermit Co.

Lavino, E. J., & Co.

Leavitt, C. W., & Co.

Metals Disintegrating Co.

**Meter Box Covers**

American Cast Iron Pipe Co.

Cast Iron Pipe Publicity Bureau

**Meters, Flow, Air, Gas**

Water

General Electric Co.

Spray Engineering Co.

**Microscopes**

Bausch & Lomb Opt. Co.

Palo Co.

Scientific Materials Co.

Thomas Co., Arthur H.

**Mills, Ball, Pebble and Tube**

Abbé Eng'g Co.

Abbé, Paul O.

Colorado Iron Works Co.

Hardinge Conical Mill Co.

Johnson Eng. Works.

Mine & Co.

Mine & Smelter Supply Co., The.

Patterson Fdy. & Mach. Co.

**Mills, Conical**

Hardinge Conical Mill Co.

**Mills, Emery**

Sturtevant Mill Co.

**Minerals and Ores**

Continuous Reaction Co., The.

Foote Mineral Co.

Lavino, E. J., & Co.

Leavitt, C. W., & Co.

Vanadium Alloys Steel Co.

**Molybdenum Ore**

Foote Mineral Co.

**Monel Metal**

Supplee-Biddle Hdw. Co.

**Montejos**

See *Acid Eggs, Cast Iron, also Stoneware*.

**Motors, Electric**

General Electric Co.

Lincoln Electric Co., The.

**Muffles**

Mine & Smelter Supply Co., The.

Russell Engineering Company.

**Nitro Compounds**

Newport Chemical Works, Inc.

**Nozzles, Spray**

American Blower Co.

Buffalo Forge Co.

Carrier Engineering Corporation.

Duriron Castings Co.

Schutte & Koerting Co.

Spray Engineering Co.

**Nozzles & Jets, Stoneware**

See *Stoneware Chemical*.

**Oils, Flotation**

See *Flotation Oil*.

**Ore Bedding and Reclaiming Systems**

Robins Conveying Belt Co.

**Ores**

See *Minerals and Ores*.

**Oxide, Gas Purifying**

Lavino, E. J., & Co.

**Paint Pigment, Graphite**

Acheson Graphite Co.

**Paints, Acid Proof & Technical**

Toch Brothers.

**Pans, Vacuum**

Badger, E. B., & Sons Co.

Blair, Campbell & McLean, Ltd.

Buffalo Fdy. & Mach. Co.

Detroit Heating & Lighting Co.

Devine, J. P., Co.

Kestner Evaporator Co.

Koven, L. O., & Bro.

Lummus, The W. E., Co.  
Pfaudler Company, The.  
Pratt Eng. & Machine Co.  
Roos', August, Son.  
Scott, Ernest, & Co.  
Sowers Manufacturing Co.  
Swenson Evaporator Co.  
Werner & Pfleiderer Co.  
Zarembo Co.

**Patent Attorneys**

See *Professional Directory*, Pages 114, 115.

**Pebble Mills**

See *Mills, Ball, Pebble and Tube*.

**Perforated Metal**

Mundt, Chas., & Sons.



**Pumps, Diaphragm**

Wayte, W. J., Inc.  
**Pumps, Gas, Liq. or Vacuum**  
 Abbe Eng'g Co.  
 Beach-Russ Company.  
 Buffalo Fdy. & Mach. Co.  
 Connersville Blower Co.  
 Crowell Mfg. Co.  
 Devine, J. P., Co.  
 Nash Engineering Co., The.  
 Pratt Eng. & Machine Co.  
 Worthington Pump & Mach'y Corp.

**Pumps, Rotary, Oil or Water**

Abbe Eng'g Co.  
 Connersville Blower Co.  
 Pelton Water Wheel Co.  
 Worthington Pump & Mach'y Corp.

**Pumps, Stoneware, Acid Proof**

General Ceramics Co.  
 Knight, M. A.  
 U. S. Stoneware Co.

**Pyrites**

Lavino, E. J., & Co.

**Pyrometers**

Braun Corporation, The.  
 Braun-Knecht-Heimann Co.  
 Bristol Co., The.  
 Brown Instrument Co.  
 Engelhard, Chas.  
 Holz, Herman A.  
 Hoskins Mfg. Co.  
 Leeds & Northrup Co., The.  
 Nehls, Carl, Alloy Co.  
 Palo Co.  
 Pyroelectric Instrument Co.  
 Sargent, E. H., & Co.  
 Schaeffer & Budenburg Mfg. Co.  
 Scientific Materials Co.  
 Shore Instrument Co.  
 Stupakoff Laboratories.  
 Taylor Instrument Companies.  
 Thomas Co., Arthur H.  
 Thwing Instrument Co.  
 Uehling Instrument Co.

**Pyrometer Installations**

Holz, Herman A.  
 Stupakoff Laboratories.

**Pyrometer Pans**

Nehls, Carl, Alloy Co.

**Pyrometer Protection Tubes**

Engelhard, Chas.  
 Herold China & Pottery Co.  
 Stupakoff Laboratories.  
 Thermal Syndicate, Ltd., The.

**Pyrometer Sheets, Graphite**

Acheson Graphite Co.

**Pyroscope**

Shore Instrument Co.

**Quartz Glass**

*See also Fused Silica*  
 Engelhard, Chas.  
 Thermal Syndicate, Ltd., The.

**Railways, Industrial & Portable**

Easton Car & Construction Co.  
 Lakewood Engineering Co.

**Recorders, CO<sub>2</sub>**

Uehling Instrument Co.

**Recording Instruments, Pressure, Temperature, Electricity, Motion, Speed, Time**

Bristol Co., The.  
 Brown Instrument Co.  
 Engelhard, Chas.  
 Holz, Herman A.  
 Hoskins Mfg. Co.  
 Leeds & Northrup Co., The.  
 Pyroelectric Instrument Co.  
 Schaeffer & Budenburg Mfg. Co.  
 Taylor Instrument Companies.  
 Thwing Instrument Co.  
 Uehling Instrument Co.

**Refractories**

*See Brick and Clay, Fire*

**Refrigerating Machinery**

*See Machinery, Refrigerating*

**Regulators, Automatic Humidity**

American Blower Co.  
 Carrier Engineering Corp.

**Regulators, Pressure**

Connersville Blower Co.  
 Taylor Instrument Companies.

**Regulators, Temperature**

Sarco Company, Inc.  
 Taylor Instrument Companies.

**Resistance Wire**

*See Wire, Resistance*

**Resistant Chemical Glassware**

Fry, H. C., Glass Co.  
 International Glass Co., The.

**Respirators**

American La France Fire Engine Co.

**Retorts**

*See Acid Distillation Apparatus*

**Retorts, Graphite**

Bartley, Jonathan, Cruc. Co.

**Retorts, Vertical**

Isbell-Porter Co.

**Halls**

*See Machinery, Crushing and Grinding and Pulverizing*

**Roofs, Walls, Partitions, etc., Concrete**

Asbestos Protected Metal Co.

**Roofings and Sidings—Fume Proof**

Asbestos Protected Metal Co.  
 Brown Hoisting Machinery Co.

## What Advertisers Offer to Readers

Classified Index of Products Advertised in This Issue by  
 Representative Manufacturers and Dealers

**Safety Devices**

American La France Fire Engine Co.

**Safety Goggles**

American La France Fire Engine Co.

**Scales, Conveyor**

Schaeffer Eng. & Equip. Co.

**Scales, Weighing**

Sturtevant Mill Co.  
 Werner & Pfleiderer Co.

**Scleroscope**

Holz, Herman A.  
 Shore Instrument Co.

**Screens**

Colorado Iron Works Co.  
 Kent Mill Co.  
 Multi-Metal Separating Screen Co.  
 Mundt, Chas., & Co.  
 Patterson Fdy. & Mach. Co.  
 Sturtevant Mill Co.  
 Worthington Pump & Mach'y Corp.

**Screens, Chain**

Codd, E. J., Co.

**Screen Doors**

Codd, E. J., Co.

**Screening Machinery**

*See Machinery, Screening*

**Separators, Air**

Aero Pulverizer Co.  
 Pratt Eng. & Machine Co.  
 Raymond Bros. Imp. Pulv. Co.  
 Williams Patent Crusher & Pulverizer Co.

**Separators, Centrifugal**

Schaum & Uhlinger, Inc.  
 Sharples Specialty Co.  
 Tolburst Mach. Wks.

**Separators, Magnetic**

Dings Magnetic Separator Co.

**Separators, Steam and Oil**

Braemer Air Conditioning Co.

**Silent Chain**

Link-Belt Company

**Silos, Wood**

National Tank & Pipe Co.  
 Redwood Manufacturers Company.

**Silver Piping**

*See Pipe, Silver*

**Silver Rod, Sheet and Solder**

Wall, A. T., Co.

**Sintering Processes**

Dwight & Lloyd Sintering Co.

**Spelter, Spiegeleisen**

New Jersey Zinc Company, The.

**Spray Nozzles**

*See Nozzles, Spray*

**Soldering and Brazing Outfits, Acetylene**

Prest-O-Lite Co.

**Sprocket Wheels**

Link-Belt Company

**Steel, High Speed**

Standard Alloys Co.

**Stills, Chemical**

*See Distilling Machinery and Apparatus*

**Stirrers, Acid Proof**

Acheson Graphite Co.  
 Durlon Castings Co.  
 Werner & Pfleiderer Co.

**Stokers**

Hagan, Geo. J., Co.  
 Laclede-Christy Clay Products Co.

**Stoneware, Chemical, consisting of**

Bottles, Carboy Stoppers, Coils and Worms, Crystallizing Disks, Chlorine Generators, Decanting Pots, Dippers, Dipping Disks, Faucets, Funnels, Kettles, Mortars and Pestles, Nozzles and Jets, Pots and Jars, Pitchers, Retorts, Receivers or Wouff Bot-tles, Sinks, Storage Jars, etc.

General Ceramics Co.  
 Graham, C., Chem. Pot'y Wks.  
 Knight, M. A.  
 Robinson Clay Product Co.  
 U. S. Stoneware Co.  
 Weeks, A. J.

**Stopper Heads**

Bartley, Jonathan, Crucible Co.

**Sulphur Burners**

*See Burners, Sulphur*

**Sulphur, Crude**

Union Sulphur Co., The.

**Sulphur Dioxide, Liquid**

Ansul Chemical Co.

**Sulphuric Acid Plants**

Kalberry Corp., The.

**Switchboards**

General Electric Co.  
 Westinghouse Electric & Mfg. Co.

**Syphons, Acid, Stoneware**

Knight, M. A.  
 U. S. Stoneware Co.

**Syphons, Metal**

Schutte & Koerting Co.

**Tachometers**

Foxboro Co.  
 Schaeffer & Budenburg Mfg. Co.

**Tanks, Cast Iron**

Detroit Range Boiler Co.  
 Stevens-Aylsworth Co.

**Tanks, Copper**

Radger & Sons Co., E. B.  
 Detroit Heating & Lighting Co.  
 Lammus, The W. E., Co.  
 Ott, George F., Co.  
 Roos' Son, August

**Tanks, Cyanide**

Redwood Manufacturers Company.

**Tanks, Enameled, Acid Proof**

Elyria Enameled Products Co.  
 Pfaudler Co., The.  
 Stuart & Peterson Co.

**Tanks, Lead Lined, Acid Proof**

Blair, Campbell & McLean, Ltd.  
 Caldwell, W. E., Co.  
 Eagle Tank Co.  
 United Lined Tube & Valve Co.

**Tanks, Steel**

Aetna Steel Products Co.  
 Baltimore Co., The.  
 Caldwell, W. E., Co.  
 Codd, E. J., Company.  
 Detroit Range Boiler Co.  
 Hamburg Boiler Works.  
 Kellogg, The M. W., Co.  
 Koven, L. O., & Bro.  
 Manitowoc Engineering Works.  
 Prest-O-Lite Co.  
 Stevens-Aylsworth Co.  
 Stevens Brothers.

**Tanks, Stoneware, Acid Proof**

General Ceramics Co.  
 Graham, C., Chem. Pot'y Wks.  
 Knight, Maurice A.  
 U. S. Stoneware Co.  
 Weeks, A. J.

**Tanks, Wood**

Baltimore Co., The.  
 Caldwell, W. E., Co.  
 Challenge Company.  
 Corcoran, A. J., Inc.  
 Eagle Tank Co.  
 Hauser-Stander Tank Co., The.  
 Kalamazoo Tank & Silo Co.  
 National Tank & Pipe Co.  
 Redwood Manufacturers Company.  
 Schwarzwald, J., & Sons  
 U. S. Wind Engine & Pump Co.

**Testing Laboratories**

*See Professional Directory, Pages 114, 115*

**Testing Machines, Metal**

Holz, Herman A.  
 Shore Instrument Co.

**Testing Sieves**

Multi-Metal Separating Screen Co.

**Thermit**

Goldschmidt Thermit Co.

**Thermocouples, Platinum**

Holz, Herman A.

**Thermometers**

Bristol Co., The.  
 Bausch & Lomb Opt. Co.  
 Engelhard, Chas.  
 Foxboro Co.  
 Gaertner, Wm., & Co.  
 Griebel Instrument Co.  
 Leeds & Northrup Co., The.  
 Palo Co.  
 Pyroelectric Instrument Co.  
 Schaeffer & Budenburg Mfg. Co.  
 Taylor Instrument Companies.  
 Thwing Instrument Co.

**Thermostats**

Sarco Company, Inc.

**Titanium**

Goldschmidt Thermit Co.  
 Titanium Alloy Mfg. Co.

**Titanium Ores**

Foot Mineral Co.  
 Titanium Alloy Mfg. Co.

**Tool Steel**

Standard Alloys Co.

**Tower Packing, Acid Proof, Stoneware**

Knight, M. A.  
 Laclede-Christy Clay Products Co.  
 U. S. Stoneware Co.

**Towers, Acid**

Durlon Castings Co.

**Towers, Acid, Stoneware**

General Ceramics Co.  
 Graham, C., Chem. Pot'y Wks.  
 Knight, Maurice A.  
 U. S. Stoneware Co.

**Tracks, Industrial and Portable**

Easton Car & Construction Co.  
 Lakewood Engineering Co.

**Transformers**

American Transformer Co.  
 General Electric Co.  
 Kuhlman Electric Co., The.  
 Thordarson Electric Mfg. Co.  
 Westinghouse Electric & Mfg. Co.

**Transformers, Special & Precipitation Process**

American Transformer Co.  
 Kuhlman Electric Co., The.  
 Thordarson Electric Mfg. Co.

**Transits**

Almsworth, Wm., & Son.

**Traps, Steam & Radiator**

Sarco Company, Inc.

**Trolleys, I Beam**

Brown Hoisting Machinery Co.

**Tube Mills**

*See Mills, Ball, Pebble, Tube*

**Tungsten Ores**

Continuous Reaction Co., The.  
 Vanadium-Alloys Steel Co.

**Turntables, Industrial Rail-way**

Easton Car & Construction Co.  
 Lakewood Engineering Co.

**Uranium Alloys**

Standards Alloys Co.

**Vacuum Drying Apparatus**

*See Dryers, Vacuum*

**Vacuum Filters**

*See Filters, Vacuum*

**Vacuum Pans**

*See Pans, Vacuum*

**Vacuum Pumps**

*See Pumps, Gas, Liquid or Vacuum*

**Valves and Cocks, Metal, Acid Proof**

Chemical Pump & Valve Co., The.  
 Cleveland Brass Mfg. Co.  
 Durlon Castings Co.  
 Lead Lined Iron Pipe Co.  
 Lunkenheimer Co., The.  
 Pacific Foundry Co.  
 Pratt Eng. & Machine Co.  
 United Lined Tube & Valve Co.

**Valves and Cocks, Stone-ware, Acid Proof**

General Ceramics Co.  
 Graham, C., Chem. Pot'y Wks.  
 Knight, Maurice A.  
 U. S. Stoneware Co.

**Valves, Vacuum**

Sarco Company, Inc.

**Vanadium Alloys**

Standard Alloys Co.

**Vats, Metal, Acid Proof**

Durlon Castings Co.

**Vats, Stoneware, Acid Proof**

*See Stoneware Chemical*

**Vats, Wood**

Caldwell, W. E., Co.  
 Challenge Company.  
 Eagle Tank Co.  
 Redwood Manufacturers Company.  
 Schwarzwald, J., & Sons, Inc.  
 U. S. Wind Engine & Pump Co.

**Viscosimeter**

Bausch & Lomb Optical Co.

**Wagon Loaders**

Link-Belt Company

**Waterproofing Compound (Liquid)**

Anti-Hydro Waterproofing Co.

**Water Tanks and Towers**

*See Tanks, Wood and Tanks, Steel*

**Water Wheels**

Pelton Water Wheel Co.

**Weighing Machinery**

*See Machinery, Weighing*

**Weighing Machinery, Auto-matic**

*See Machinery, Automatic Weighing*

**Welding and Cutting, Oxy-Acetylene**

Prest-O-Lite Co.

**Welding Materials**

Acheson Graphite Co.  
 General Electric Co.  
 Goldschmidt Thermit Co.  
 National Carbon Co.  
 Prest-O-Lite Co., The.

**Welding Outfits, Arc**

General Electric Co.  
 Lincoln Electric Co., The.

**Welding Thermit Process**

Goldschmidt Thermit Co.

**Winches, Electric**

Volts Mfg. Co., The.

**Wire Cloth**

Multi-Metal Separating Screen Co.

**Wood Distillation**

*See Apparatus, for*

Radger, E. B., & Sons Co.  
 Blair, Campbell & McLean, Ltd.  
 Dev



## *Palpably Perfect*

We spare neither pains nor expense in the process of manufacture or in the methods and thoroughness of inspection of

# BAKER Platinum Apparatus

Having done everything in our power to insure the obvious perfection of our ware at the time of shipment, we go farther than that and guarantee it to give entire satisfaction.

Any article of Baker manufacture which should develop inherent defects which become apparent only when the material is subjected to conditions other than those involved in its manufacture, is returnable in exchange for a perfect one.

Choice of a great variety of articles is offered from our large stock.

Send sample or drawing, giving complete dimensions, for estimate on special articles.



**BAKER & CO., INC.**  
Newark, N. J.

New York Office:  
Thirty Church Street





# Acid-Proof Chemical Stoneware

## *A Few Important Facts*

We do **not** depend upon a glaze enamel or veneer to make our ware acid proof.

**It is the body itself.**

Our **entire** organization has been making acid proof chemical stoneware for over **ten years.**

We are the only plant in the country which is devoted **entirely** to the manufacture of acid proof chemical stoneware.

Our ware is **not** the cheapest nor is it fancy, but it is **guaranteed** to be acid proof, free from defects, not to leak or sweat and to be perfectly satisfactory in every respect.

The **first** cost is a very small item when you consider the great loss caused by shut-downs in a system on account of leaky or defective stoneware.

"The sweetness of low prices never equals the bitterness of poor quality."

Our clay and method of manufacture is **not** the same as used by others in our district.

We make **every description** of acid proof chemical stoneware, from special pieces to complete plants.

We make a specialty of ware for **nitric acid** manufacture.

Our ware will withstand the action of acids, alkalies and chemicals, hot or cold, weak or strong.

We do not give a **promise** of quick delivery to procure your order, then disappoint you.

Our motto: **Service and honesty in deliveries.**

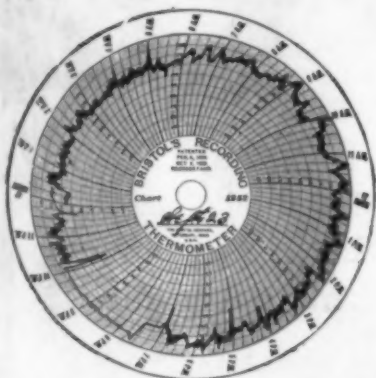
Try us on **all** of these points or let us refer you to some of our satisfied customers who have used our ware for the past ten years.

**Remember it is the body itself.**

*Let us send you circulars and particulars*

**MAURICE A. KNIGHT** Office  
Kelley Ave. **East Akron, Ohio**





## THE TRUE STORY

Of the entire day's operation can be had by a glance at the chart record made by

TRADE MARK  
**BRISTOL'S**  
REG. U. S. PAT. OFFICE.

Recording Instruments. The Chart Records show the actual conditions and charts should be filed so as to compare results. In this way you can detect error—cut out waste and reduce operating expense.

Temperatures of Feed Water—Flue Gas—Economizer—Superheater—Condenser and Plant Heating are important items in the day's run.

Do you keep records? Do you know just what goes on?

Write for Bulletin 204-B.



## THE BRISTOL COMPANY

Waterbury, Conn.

BRANCH OFFICES

Boston

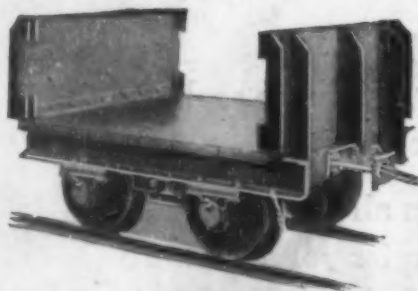
New York

Pittsburgh

Chicago

San Francisco

## EASTON INDUSTRIAL RAILWAY CARS

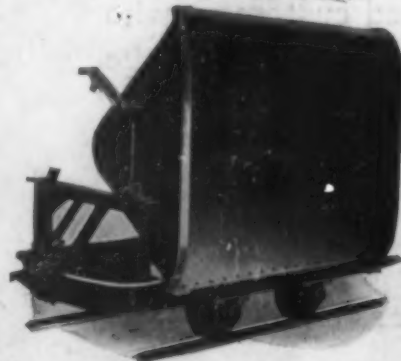
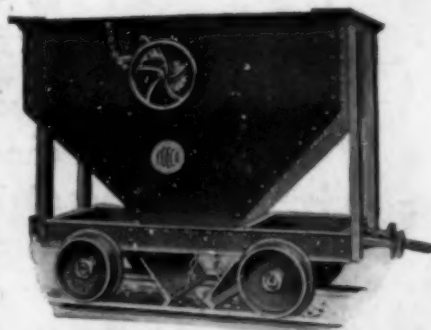


If it is an Industrial Car we make it. Whether it be the standard rocker bottom dump car or a big special car for steel mill or other service.

If it is a complete Industrial Railway Installation we have the experience and the skilled engineers to plan it correctly and the facilities and ability to design and build it and all parts of its equipment.

Industrial Railway Transportation problems may be entrusted to us in the absolute assurance that they will be satisfactorily and economically solved.

Send for our new  
Industrial Catalog  
No. 5081



**Easton Car & Construction Co.** (Dept. A) 4th and Northampton Sts.  
Easton, Pa.

New York

Boston

Detroit

Chicago

Pittsburgh

